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Salient Characteristics of Fuel Oil

By A. P. Bjerregaard

Chief Technologist, Empire Refineries, Inc.

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By Grady Triplett

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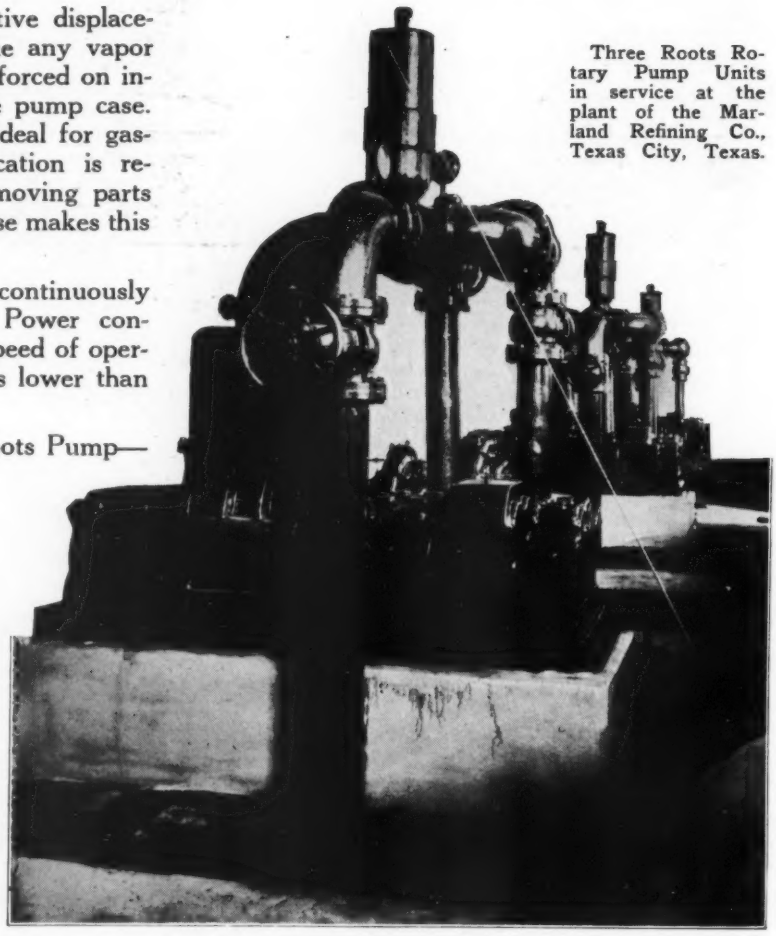

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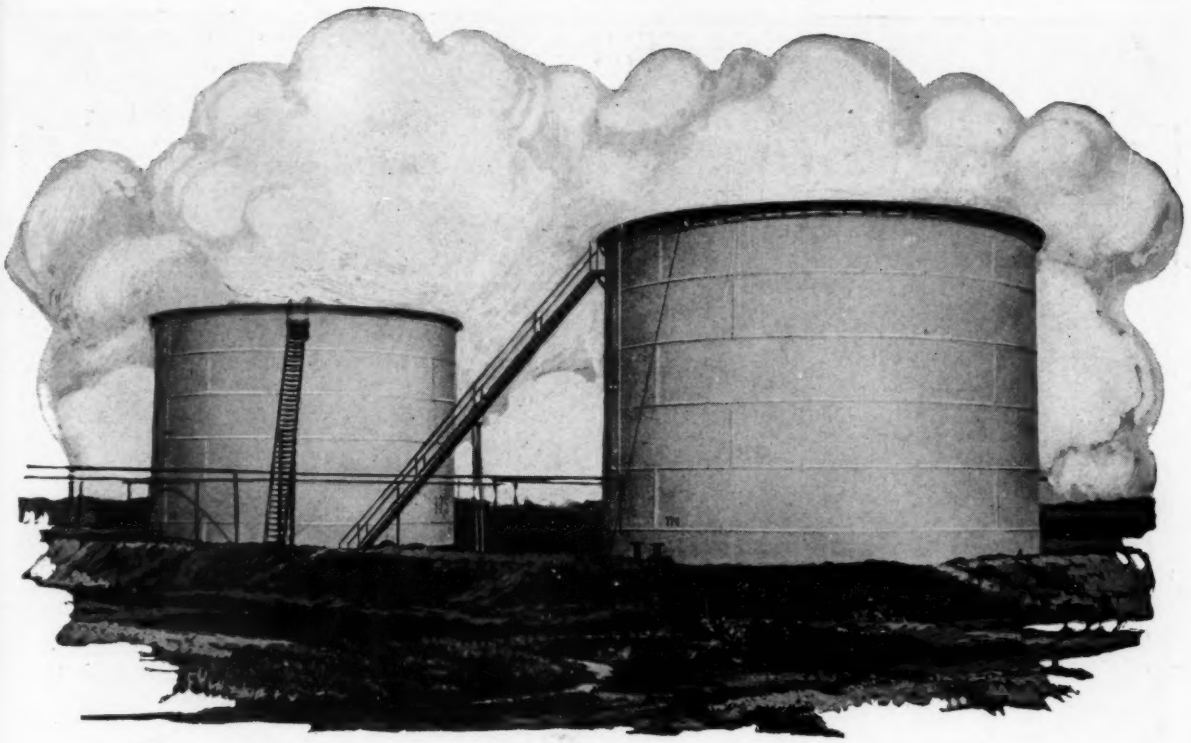

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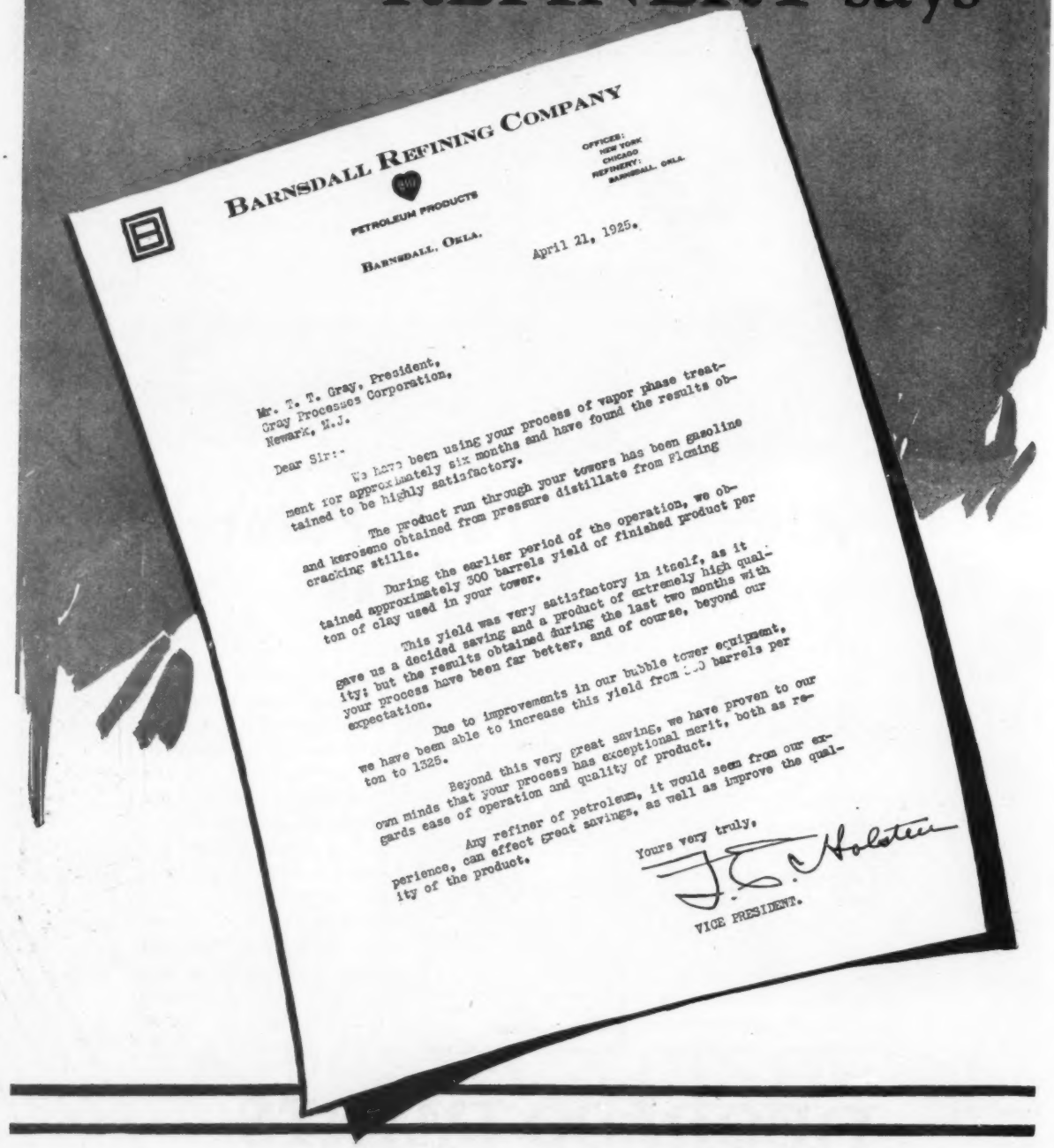

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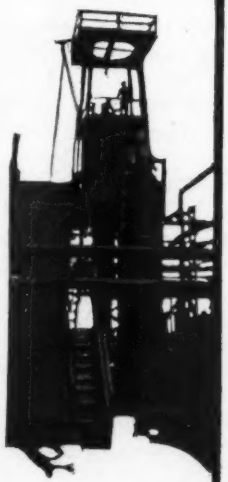

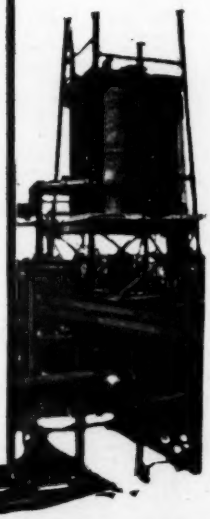

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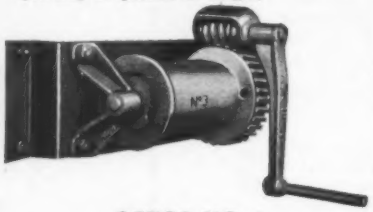

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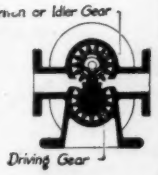

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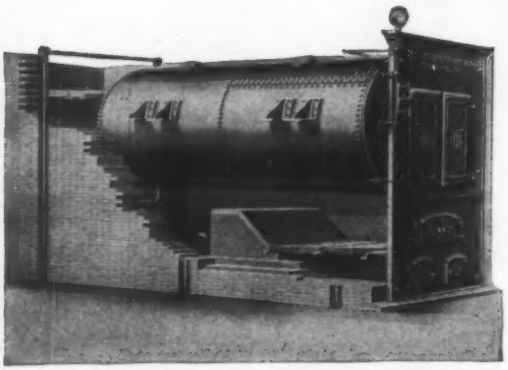

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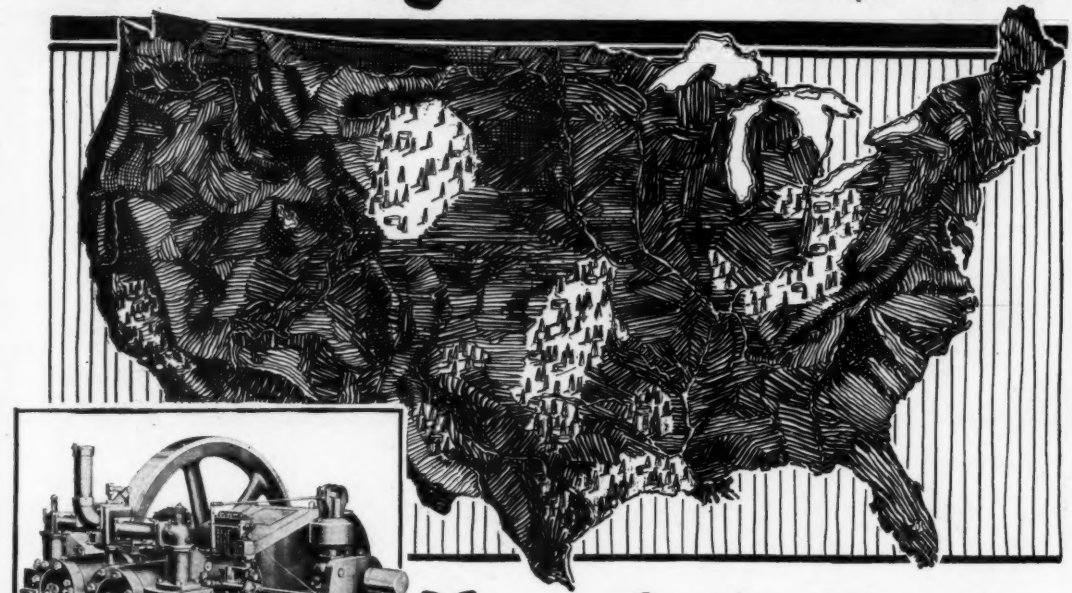

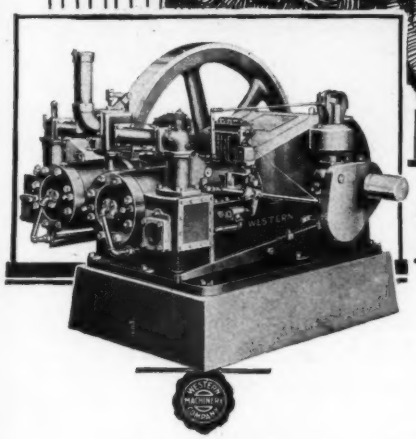

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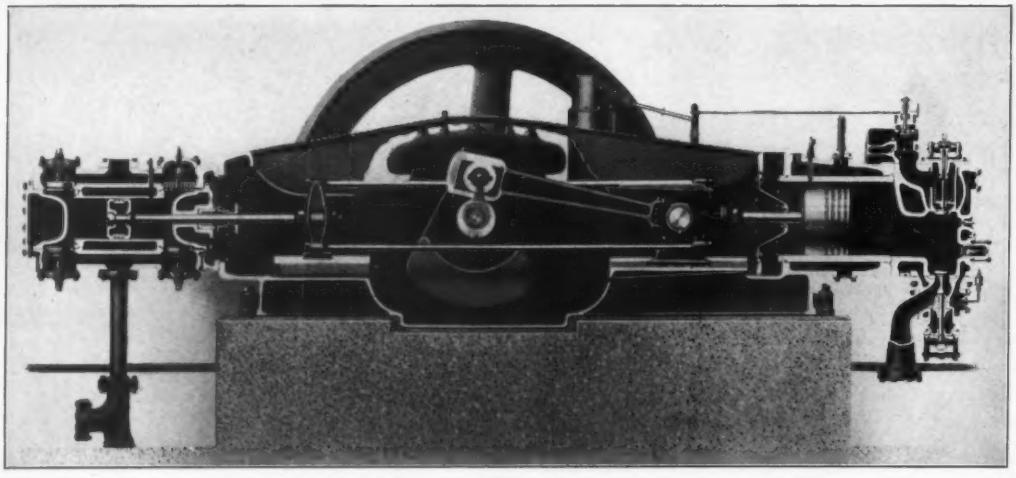

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Salient Characteristics of Fuel Oil

This message to the user of fuel oil contains knowledge that is of value to the maker of the product*

By A. P. Bjerregaard
Chief Technologist, Empire Refineries, Inc.

FUEL Oil is one of the many products of petroleum, and it is marketed in several modifications or varieties.

As is well known, crude petroleum in the condition in which it comes from the ground is of very little use. It must be separated into various constituents by processes, principally distillation processes, which have been devised for that purpose. When typical crude oil is distilled, the following series of substances come off one after the other as the temperature gradually increases during the distillation.

Uncondensible gases,
Gasolines,
Naphthas,
Kerosenes,
Gas oils,
Thin lubricating oils,
More viscous lubricating oils.

Each of these can be and are made in very many grades and varieties, and the last two are often admixed more or less with paraffin wax, which must be separated before the lubricating oil can be efficiently used.

There remains in the still a residuum which will differ according to the kind of crude, the extent of the distillation and the method of distillation used. If the distillation is pushed to its limit the residuum will be coke and not oil.

Classes of Fuel Oil

The distilled products, except gas oil and furnace oil for house heating, will not be further considered in this discussion, although the gasoline and the kerosene are, strictly speaking and in a broad sense fuel oils, since they are utilized by processes of combustion.

However here the term fuel oil will be used in the narrower sense of an oil which is burned in a furnace for the production of heat, which heat can then be utilized in various ways. This definition of fuel oil would exclude diesel and semi-diesel fuel oils, but as they are in nature similar to or identical with the fuel oils included in the above narrow definition, we will consider that they also are included among the oils herein discussed. We will also include here those crude oils which are used directly as fuels and which do not contain sufficient light distillable constituents to warrant subjecting them to the distillation process.

These fuel oils may be classified under seven heads, thus:

1. Residues from distilling crudes.
2. Gas oils.
3. Blends of residues from crude and gas oils.
4. Residues from pressure distillation processes.
5. Blends of class 4 and class 1.
6. Naturally occurring crude oils.
7. Oils of classes 1 and 6 which have been subjected to a special heat treatment.

Residues From Crude

We will consider then first the residual oils left in the still after distilling off part of the crude oil. This residual oil may amount in some cases from some crudes to a very large proportion of the crude oil, as for certain Mexican crudes. In other cases with other crudes the amount of such residue will be relatively small, as is the case for most Mid-Continent crudes. The amount will also differ, naturally, according to the extent that the distillation has been carried in any particular case.

With some crudes, as for example, with many of those found in the Pennsylvania region, as well as some found in the Mid-Continent region, the residue is of greater value as a lubricating oil than as a fuel oil, such residua are outside the scope of this paper.

The oils of this class may vary somewhat in properties, but they are all dark colored or black, and they all have considerable body or viscosity, and usually they have quite high flash points. They vary considerably in gravity, but are mostly somewhat heavy, say from 30 to 10 Baume gravity or heavier.

A subvariety of this kind of fuel oil consists in the residues from redistilling heavy lubricating oils, both waxy and non-waxy. These oils resemble those above described very closely, although sometimes they are not quite so densely colored in thin layers, yet they usually look black in mass.

Gas Oils

The second class of oils we must consider are the gas oils and furnace oils. These are intermediate distillate oils which are too heavy for kerosenes and too thin for lubricating oils. When pure they are light colored, but as they are often handled through the same pipe lines as the residual fuel oils they may be more or less dark colored from the intermixture of small amounts of the latter. Some times the oils of this class are residues left in the still when redistilling raw kerosene distillates. These residual gas oils will also be dark colored.

Except for the color, all these oils are alike in general properties. They are all very thin in body, have medium flash points and are intermediate in gravity. The gravity depends so much on the crude from which any particular gas oil may be derived that a statement of the range will not mean much. But in general they will vary in grav-

*Read before the National Association of Purchasing Agents May 27, at Milwaukee, under the title "What Is Fuel Oil?"

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ity from about 23 to 40 degrees Baume.

Gas oils are the favorite raw materials for the various cracking processes for making gasoline, therefore gas oil is usually quite considerably higher in price than the heavier residual fuel oils.

Blended Oils

The heavy residual fuel oils are frequently blended with more or less gas oil in order to prepare fuel oils of specified gravities. This, of course, is a perfectly legitimate method of accomplishing this end. By this means also the high viscosity of some residual fuel oils can be overcome, since gas oil has very little viscosity. Usually these blended oils are not distinguishable from the ordinary residual fuel oils of the lighter ranges of gravity and of the thinner types of body.

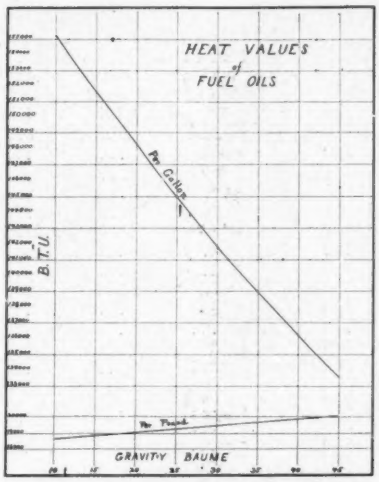
Blends of gas oils and heavy residual oils sometimes deposit black granular sediments of asphaltic matter. This is caused by the lack of solvent power by the gas oil for certain constituents of the heavy residual oil. One method for overcoming this objectionable deposit is to store the blend in tanks long enough for this sedimentation to take place there and then pump off the clear supernatant fuel oil for use or shipment. This method is actually used by some refiners.

The sediment referred to is a good fuel if it could be gotten into the combustion chamber, but unfortunately it has a strong tendency to clog up pipes, pumps, valves, burners, etc., which makes its presence highly undesirable. It has been proposed to put these sediments through so called colloidal mills in order to grind the asphaltic matter so fine that it will remain suspended in the fuel oil and so contribute to its heat generating value. This process looks encouraging and it is probable that it will become of more or less general use. This grinding process will be discussed in a little more detail when we come to consider the fuel oil residues from pressure stills.

Pressure Fuel Oils

Some of the most desirable fuel oils are the residuals from pressure processes for making gasoline from higher boiling point oils. These pressure fuel oils are black in color, thin in body, and often of very low cold test, but they very frequently contain suspended carbon particles. These, if large, would tend to clog the fuel oil supply system to the burners and the burners themselves. Therefore, these oils are usually well settled before use or shipment.

To overcome this defect these oils are sometimes ground in a colloid mill, already mentioned, so that the carbon particles are disintegrated to such a state of fineness that they will not settle nor agglomerate, nor interfere with the flow of the oil through the supply system or the burners. Since the carbon thus present has a high calorific value, no objection should be raised to its presence, even if the sedi-



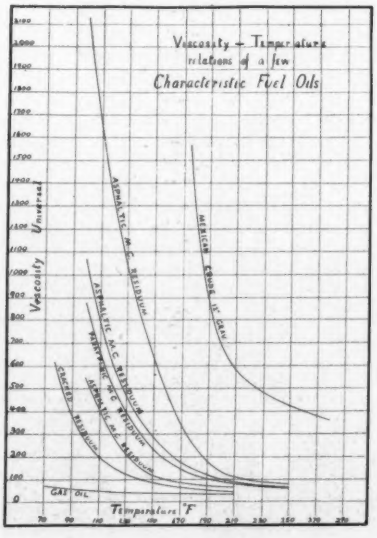
mentation or centrifuge test (to be considered later herein) shows its presence in the oil after the same has been diluted. Remember that the oil is not diluted for use and the carbon particles have been so finely dispersed as to be free from all objection in actual use. So it is proper to accept such oil if it is otherwise acceptable.

These pressure fuel oils are always quite heavy in gravity, heavier than 25 degrees Baume, and therefore as will be shown below are high in heat generating value.

Blends of Classes 1 and 4

A fifth class of fuel oils is formed by the blends of pressure still residua with the residua from crude oils.

In some respects this class of fuel oil is similar to class 2, since it is a blend of a thin bodied oil and a heavy bodied oil. Like the oils of class 2, the oils of this class also frequently deposit heavy asphaltic sediments, which are just as troublesome as those of class 2. However, the cause of the sediments in this class is different. Here the asphalt originates in the thin oil, namely, the pressure still residuum.



Some of the asphalts in solution in the pressure product are not soluble in the straight crude product. Besides this, of course, there may also be present coke in a more or less divided state. The colloid mill can be of great assistance in this class of fuel oils in rendering them homogeneous enough to be stable against separation and agglomeration.

The oils of this class are always black, intermediate in viscosity and mostly heavy in gravity.

Crude Oils

A sixth class of fuel oils are those naturally occurring crude oils which are used normally as fuel oils, such as heavy Mexican crude, Smackover crude, and some others. These oils are usually highly asphaltic and often very high in sulphur. They are generally heavy in gravity and of high viscosity. These crudes also frequently contain high percentages of emulisified water, not to speak of the occurrence of leaves, sticks and dirt of various kinds derived from the open earthen reservoirs in which such crude oils are often stored.

Recently a process has been proposed for subjecting the highly viscous and heavy gravity oils to high heat and pressure, whereby they are converted into thinner oils of heavy gravity, without the production of any gasoline. This process has not yet come into sufficiently extended use to allow of anything being said as to its merits and demerits.

The idea must not be gotten that all fuel oils are heavily loaded with sediments of various sorts. It is true that much has been said above on these sediments, but after all they are very often absent, and when present they are always in small amount. In an impartial discussion such as this is it has been necessary to speak of them, but they are by no means of such overwhelming importance as the space they occupy in the above discussion might lead one to suppose.

Characteristics of Fuel Oil

Considering now the various properties or characteristics of fuel oils as above defined and delimited, we will take them up in order as follows:

Color.
Body or viscosity.
Flash point.
Pour point.
B. S. and water.
Gravity.
B. T. U. or heat generating capacity.
Chemical composition.

Details of methods for making the various tests discussed herein will not be entered into. These details, however, are always of extreme importance in order to obtain true and concordant figures for the several characteristics. In order to be able to obtain proper test results the methods of test described by the American Society for Testing Materials should be exactly followed.

The first physical property noted is the color. This is usually black or

dark olive or dark green, and except for distilled oils, as some gas oils, always very dark. The color of the fuel oil has no bearing on its value as a fuel oil and this property will not be further considered here except to say that fuel oil made from the same crude in the same plant may vary in color somewhat according to the details of the distillation processes to which the crude has been subjected. Unless this difference in treatment has also affected other more pertinent properties of the oil, no attention should be paid to the difference in color.

Body or Viscosity

The next property noticeable is the so called body of the oil. This may be thin or thick, and all graduations in between.

The body varies with the temperature and becomes thinner the higher the temperature. Technically the body is called viscosity and in the case of fuel oils it is measured in an instrument called a Furol viscosimeter. The usual temperature specified for taking the viscosity of fuel oils is 122 degrees Fahrenheit (50° C).

The viscosimeter, whether Furol or other type, consists essentially of a narrow tube surmounted by a containing vessel, both being surrounded by a water bath for cntrolling the temperature. The viscosity is stated in terms of the number of seconds it takes for a specified volume of oil to flow from the containing vessel through the narrow tube. The size of the tube and of the containing vessel, and the standard amount of oil allowed to flow out, vary with different types of instruments and therefore the numerical values obtained differ. Tables and formulae of comparison for many of the instruments have been published so that in most cases they can be interconverted by calculation, provided that the temperature at which the viscosity was taken was the same. Unless this last condition is true the conversion can not be made with even a fair approximation to accuracy.

As stated above the viscosity varies with the temperature and it becomes less the higher the temperature. The rate of change also varies with the temperature, it is greater at lower temperatures than at higher.

The following table gives a few viscosity-temperature data, taken by means of the Saybolt Universal viscosimeter, for a few characteristic fuel oils.

It has been necessary to use the Universal instrument for these data because the figures obtainable on the Furol instrument would be too small to be accurate. Very small figures by any viscosimeter are never accurate because the conditions of flow through the orifice changes. However, in order to show the comparison, the Furol figures calculated by the Bureau of Standards factors are also given in the next following table. The gas oil is omitted there and a line of stars shows the demarkation below which the figures are inaccurate.

TABLE SHOWING VISCOSITY-TEMPERATURE DATA BY UNIVERSAL VISCOSIMETER FOR A FEW CHARACTERISTIC FUEL OILS

Temp.	Mid-Cont. Gas Oil	M. C. Asph. Fuel Oil	M. C. Asph. Fuel Oil	M. C. Paraf. Fuel Oil	M. C. Asph. Fuel Oil	Mexican Crude	Cracked Resid.
(Grav.)	36.0	21.3	14.7	20.7	22.7	12.0	...
280		...	...	...	...	38	...
70	69	...	...	...	...	...	...
77	...	...	...	...	...	...	620
90	54	...	...	...	...	...	...
100	50	1070	2130	889	553	...	270
110	47	...	...	...	...	...	...
130	41	...	...	...	...	...	...
150	38	283	630	238	122	...	...
170	36	...	...	...	...	...	...
175	...	...	...	...	...	1575	...
190	34	...	...	...	...	...	...
200	...	...	...	...	...	695	...
210	33	88	113	81	61	...	45
225	...	...	...	...	...	500	...
250	...	66	80	63	52	...	...
280	...	...	...	...	...	362	...

TABLE SHOWING VISCOSITY-TEMPERATURE DATA BY FUROL VISCOSIMETER, CALCULATED FROM ABOVE DATA

Temp.	M. C. Asph. Fuel Oil	M. C. Asph. Fuel Oil	M. C. Paraf. Fuel Oil	M. C. Asph. Fuel Oil	Mexican Crude	Cracked Resid.
77	...	...	...	...	...	63
100	108	213	90	57	...	30
			****	****		****
150	31	64	27	16	...	...
175	...	...	...	...	158	...
200	...	...	...	...	70	...
	****	****				
210	15	16	14	12	...	9
225	...	...	...	...	51	...
250	12	13	12	10	...	...
280	...	...	...	...	38	...

The Universal viscosity figures are plotted on the accompanying diagram by which it will be seen that all the curves are more or less alike in shape and at lower temperatures show a very steep slope which becomes a very flat slope at high temperatures. It will also be seen that there is a tendency for the viscosities of all the oils to become the same, or nearly the same at temperatures above 212 degrees Farhenheit.

If the Furol viscosities were plotted in a similar way the curves would be very similar to those shown.

The viscosity of fuel oil is of importance as related to the power required to force the oil through pipes, and as related to the flow through the burner tip, as well as to the degree and ease of atomization on leaving the burner. But since viscosity varies so greatly with temperature, that important factor must necessarily be taken into consideration in all calculations, and in all studies of the action and efficiency of burners.

It is quite a common and customary practice to keep the heavier kinds of fuel oil warm, or even hot, by closed steam coils, thus rendering them more fluid. This is especially desirable for fuel oils for Diesel and semi-Diesel engines. The hot exhaust gases can sometimes be utilized for this purpose.

Viscosity is of no importance when lighter fuel oils such as gas oils and furnace oils for house heating are under consideration. These oils are all very thin in body and change in viscosity with temperature much less than the heavier bodied oils above considered. These oils do not need to be heated to enable them to flow freely unless they become cooled to a low enough temperature to cause a separation of crystals of paraffin wax, and this usually requires quite a low temperature.

Flash Point

The next characteristic we will consider is the flash point. This is of little importance provided it is not so low as to make the storage and use of the oil dangerous. It indicates the temperature at which under the conditions of the test the oil gives off inflammable vapors. As the temperature in the flame is enormously greater than the highest flash point possible in any petroleum oil there is little danger, if any, of having too high a flash point in any commercial variety of fuel oil which is to be burned in a furnace.

For some semi-Diesel engines the flash should not be too high, otherwise there might be difficulty in ignition. But according to W. Schenker, chief engineer for Sulzer Bros.' factory in Switzerland, the flash of Diesel engine fuel oil can not be too high for use in that type of engine, and it must be high enough to avoid danger.

For certain types of house heating furnaces the furnace oil must have a low flash point in order to be easily ig-

(Continued on page 26)

Deepwater Paints Its Own Tank Cars

By A. R. McTee
Staff Representative

BY painting its own tank cars the Deepwater Oil Refineries, Houston, Texas, has cut expenses at least $1200 each year. In addition to this saving, it is the opinion of officials of the refinery that the paint jobs their own men turn out are superior to those done by the average car painting contractor. Considering the cost of the paint and work and the appearance of the cars when painted, with the length of time the paint stays on, the company believes it profits from every standpoint by painting its own cars.

The Deepwater company owns its cars and paints on an average about 80 each year.

When a car needs paint it is rolled onto the switch set aside for repair work and a "Car Being Repaired" sign is put on it, to make sure that the car will not be moved through mistake.

Cleaning is the first step in the painting job. This is done with the aid of a wire brush operated by compressed air. This brush operating at about 900 revolutions per minute under 75 pounds air pressure is used to clean the car of old paint, rust and scale. If further cleaning is necessary the car is washed with gasoline. The rivets are cleaned by hand.

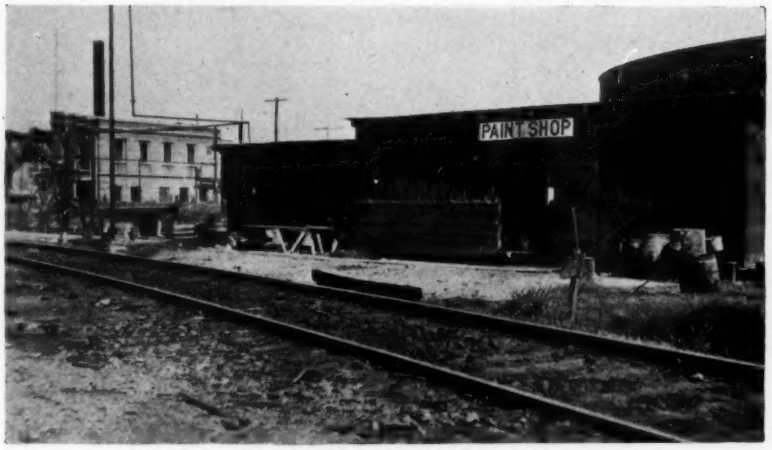
Spray Gun Used

When thoroughly cleaned and dry, the primer coat of paint is put on the body of the car with a paint spray. For this purpose the Deepwater company uses Degra 125 primer.

While the primer coat on the body is drying, the frame and bottom of the car are painted with Degra underframe paint. The spray is used for this coat also.

When the primer coat is dry a coat of Degra Enamel, number 131 is applied to the body of the car, and the lettering is put on. Then when this coat is dry ,the car is ready for use.

Lettering is done both with and without the aid of stencils. For the smaller ones stencils are used altogether, but a few of the larger letters, and some of the numbers are put on by expert painters.



The paint shop and siding, where cars are set for painting

Spraying device used in painting

The paint spray used by the Deepwater men is a home-made one, made by E. E. Hays, paint foreman. This spray will paint as much surface in one day as seven men can, and it does excellent work. Its total cost was $35. The spray operates on 75 pounds air pressure and carries 150 feet of hose. It is light in weight and can be handled by one man.

Equipment Used

Equipment for painting tank cars cost the Deepwater Company possibly $1000 and consists of air brushes for cleaning, stenciling machines, the paint spray, scaffolds to fasten on the sides of the car, and various items of miscellaneous equipment such as brushes, etc. However, practically all this equipment, with the exception of the scaffolds can be used in other paint jobs such as painting tanks, steel buildings, etc., so that little of it is special apparatus for the tank car work.

Between two and one-half and three days are required to finish a car, allowing for drying time. Usually two men do the work and use about seven gallons of paint.

Air for operating the paint spray and wire brushes is obtained from the boiler house where the general-purpose compressor is located.

The company averages painting each of its cars once every two years and considers this an exceptional record inas much as the refinery is located directly behind a chemical manufacturing plant. This causes the tank cars, while they are standing in the refinery yards, to get all the fumes from the chemical plant in addition to those from the refinery. Naturally under such conditions paint on the cars is subjected to tests much more severe than under ordinary conditions. Several kinds of acids are made at the chemical plant and fumes from these acids are continually drifting out over the tank cars.

Ready for the road, after a visit to the Deepwater paint shop.

Refining plant of the Magnolia Petroleum Company at Beaumont where the absence of smoke from most of the stack

Magnolia Accomplishes Real Conservation

By burning natural gas at Beaumont plants 7,000 barrels of fuel oil is saved daily

By Grady Triplett
Staff Representative

Beaumont, Texas.—The visitor arriving at the refinery of the Magnolia Petroleum Company here, is impressed by the absence of smoke issuing from the stacks. Where but a few months back, each stack poured forth its volley of black, now those of only one boiler house belong to that class. These pull the draft over fires where acid sludge and other refuse are burned.

A similar condition exists at the skimming plant of this company 10 miles further down the Neches river. The two are the only plants of the Beaumont-Port Arthur refining district that are distinguished by smokeless stacks over still batteries and boiler houses.

Elimination of smoke has come with the adoption of gas for fuel. Use of gas began last December but it was February of this year before sufficient equipment had been converted to this fuel to give the plant the distinction of smokeless stacks.

Stroke of Conservation

From another viewpoint the absence of smoke is evidence of a stroke of conservation of which the petroleum industry may be proud. Gas for fuel is nothing new in refinery operation. But the change in the two Magnolia plants is the only instance of a concern piping gas more than 200 miles at a cost of around $8,000,000 in order to accomplish a substantial stroke of conservation of petroleum.

It has long been accepted that the disposition of fuel oil is one of the serious problems of successful refinery operation. Under the old scheme, the Magnolia had an outlet for a large share of its fuel oil in its own furnaces. The substitution of natural gas has given its sales department the task of disposition of 7000 additional barrels of fuel oil daily.

In March the Magnolia plants consumed 1,197,002,000 cubic feet of natural gas. Of this, the Beaumont refinery required 1,118,638,000 cubic feet, leaving 78,364,000 for the skimming plant at Magpetco.

The average daily consumption of natural gas for March was 39,900,000, stated in round numbers. To have created corresponding heat value from fuel oil would have required the burning of 7372 barrels daily.

Heat Values

Calculations made at the Magnolia offices show that it requires the burning of 5412 cubic feet of natural gas to generate the heat that came from one barrel of fuel oil. This figure was found by comparative calculations. From experience of past years, officials of the company knew how much fuel oil was consumed in the refining of a given amount of crude oil, for instance the running of 100,000 barrels.

One of the Chaplin-Fulton regulators, controlling the gas for furnace pressure.

...ual of conservation. This plant is now burning gas, which has replaced 7,000 barrels of fuel oil each day.

By calculating the amount of natural gas necessary for running a corresponding amount of crude oil, the heat value of natural gas as compared to fuel oil was found.

This heat value of natural gas and fuel oil comes from actual operation in the two Magnolia plants. Changed operating condition may alter it slightly but it comes so near to the theoretical heat ratio of the two fuels that little change can be expected. Experiments are still being made as to pressures and burners best adapted to refinery use. It is in these that changes may take place in the number of cubic feet of gas rquired to generate the heat that came from one barrel of fuel oil.

Natural gas for the two Magnolia plants is collected and delivered by an affiliated concern, the Magnolia Gas Products Company, a Delaware corporation of 100,000 shares no par value stock, of which Fred M. Lege, Jr., is president.

The gas is transported from the Cotton Valley district of North Louisiana through 215 miles of welded pipe line of three sizes. There are 45 miles of 14-inch pipe; 99 miles of 16-inch pipe; and 71 miles of 18-inch pipe. Weight of the pipe varies from 42 to 63 pounds, the heavier and smaller size pipe being placed on that part of the line leading from the pump stations, as pressures there are highest.

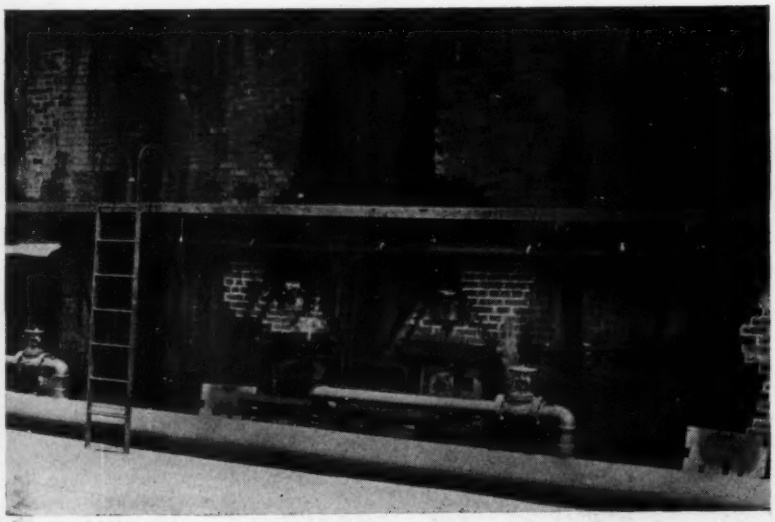
The gas is delivered in an 18-inch main to the bank of the Neches river opposite the refinery at Beaumont. A special manifold was used for a river crossing. At this point seven 8-inch lines, each 800 feet long, laid parallel and fastened together with special clamps. This manifold was bent to conform to the channel dredged across the river. Extra heavy pipe was used for the double purpose of giving strength and at the same time make it unnecessary to use the usual type of river clamps to gain weight.

On the refinery side of the river, these eight lines converge into a header, which feeds into an 18-inch main. This main runs across the front of the refinery property. After passing the refinery site, the main reduces to 12 inches, going on 10 miles to the skimming plant at Magpetco.

Gas is taken into the refinery through 12-inch leads. There are six of these, each running at right angles from the 18-inch main. Then the gas passes from these 12-inch leads into the main yard lines, which in turn feed the gas into the lines that run to the boiler houses and batteries of stills.

The gas is metered for each battery of stills or each boiler house. By measuring for these units, calculations can be made as to the amount of gas consumed in running the crude oil for each battery or for generating the steam at each boiler house. Westcott batteries are used.

Regulators within the refinery property reduce the pressure from that at which it comes to the plant down to that required for burning.



A gas main in front of a battery of stills, showing lead line and manifold into the furnace. The oil lines against the furnace walls.

Pressure Reduced

The gas comes into the plant at around 300 pounds pressure. As it passes from the 18-inch main, regulators step the pressure down to 50 pounds, at which it passes through the six leads into the refinery property. As it passes from these lead lines into the yard mains, other regulators bring the pressure from 50 pounds down to 10 pounds.

From the yard mains, the pressure is brought down to four ounces or higher as it goes into the lines that feed the batteries of stills or the boiler houses.

At present gas is being burned at pressures from 4 ounces to 20 ounces. In the matter of pressure, experiments are still under way, just as they are under way in the matter of the type of burner best adapted for stills or boilers. Most of the burners known to

(Continued on page 48.)

NO LEAKS
In Riveted-Welded Joints

Unsolicited praise of efficient and satisfactory service is the best endorsement. The type-set insert is part of a letter relating to a recent installation of Vogt Stills in a large refinery. The name of this company will be given on request. The Vogt Riveted-Welded Joints on High Pressure Stills have the combined strength of both, that assures no leaks under high pressures and temperatures. Our correspondence files are replete with letters, such as this one, expressing satisfaction of efficient service, workmanship and design of Vogt Refinery Equipment.

"We wish to particularly call to your attention and assure you that we appreciate the fine workmanship done on the stills. The stills have now been in service two months and we have not had a single noticeable leak on the stills proper. This we consider quite remarkable."

Vogt Stills

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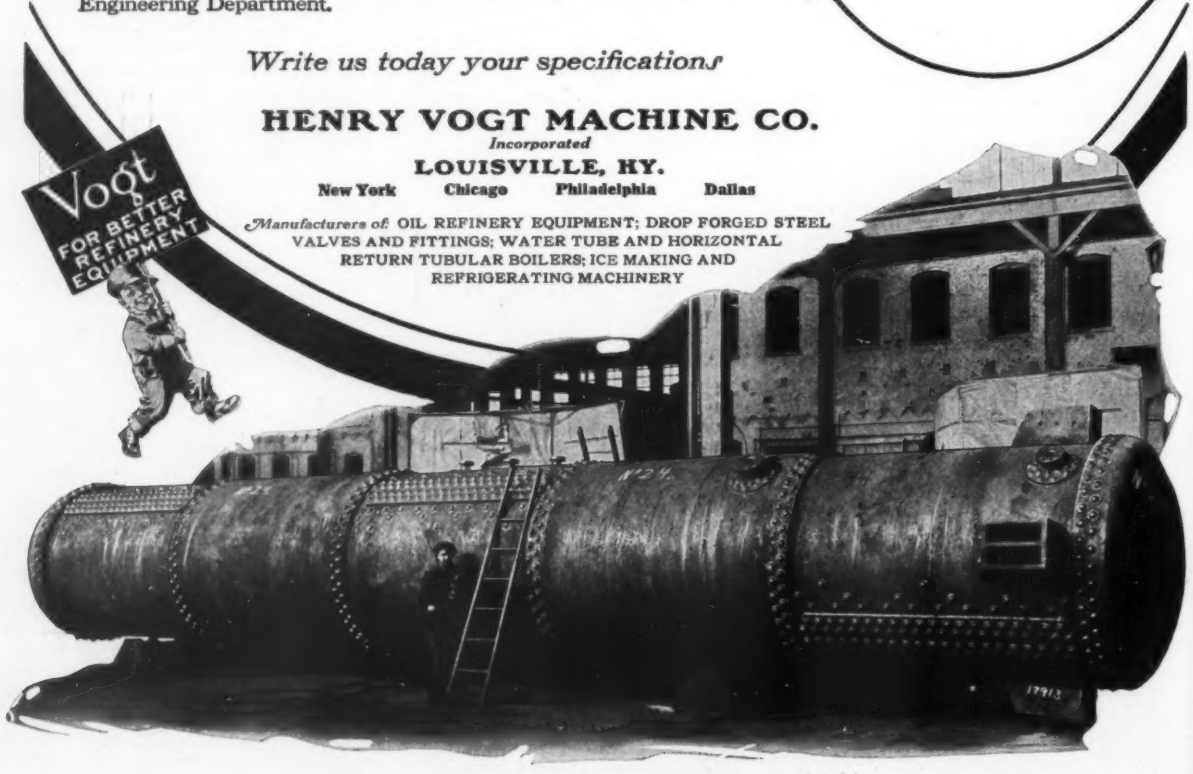


Tell them where you saw the ad.

General Principles of Charcoal Testing

The methods of making this test are presented so they can be followed by the man in the field

By W. R. Lentz
Chemist, Chestnut and Smith Corporation

IT was during the World War that the idea of using charcoal as an absorbing medium to remove gasoline from natural gas was conceived by George Oberfell, who was, at that time, in that branch of the government service which dealt with poison smokes and gases. It was no more than natural that Mr. Oberfell should have conceived this idea, having been connected with the natural gasoline industry for a number of years previous to his service with the government. The charcoal first experimented with was the same as that used in the gas masks to absorb poison gases.

The charcoal used in the present charcoal testing method is what is known as activated charcoal and is made mostly from cocoanut shells by first submitting them to a dry distillation and then subjecting them to a steam treatment of approximately 1600 degrees F. This application of extreme heat renders the charcoal very dry and porous. The porosity of the charcoal is one of the factors effecting the efficiency of gasoline absorption.

The activated charcoal is graded into what is known as 40, 50 or 60 minute, which is regulated by a test developed during the World War, known as the Accelerated Chlorpicrin test. This test consists of passing a mixture of chlorpicrin gas and air through a specified amount of charcoal at a given rate and the number of minutes noted in which the charcoal will completely remove the chlorpicrin gas. Thus, the term 50-minute charcoal, which is the grade generally used in the charcoal testing apparatus.

Charcoal Qualities

Another specification of the charcoal used is the mesh, or in other words the size of the granules. The charcoal used is generally 8 to 14 mesh. A charcoal having a finer mesh than 14 would have a tendency to pack in the charcoal tube thereby obstructing the flow of gas. A charcoal having a much larger mesh than 8 would, of course, allow too free a passage of gas due to the unoccupied spaces between the granules of charcoal, thereby decreasing the efficiency of extraction.

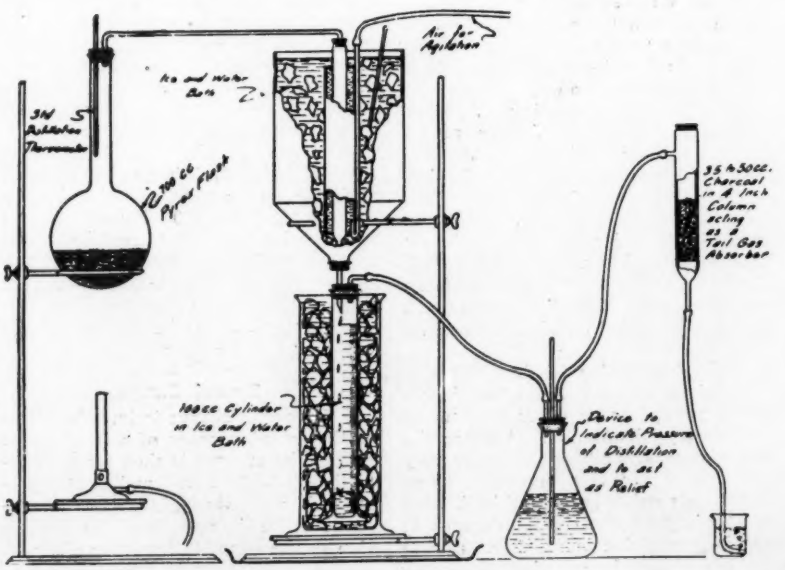
The moisture content of the charcoal, of course, regulates the absorbing efficiency. It has been determined that a moisture content not exceeding 4 per cent by volume will not impair the absorbing qualities of the charcoal. Activated charcoal should always be kept in an air tight container due to the fact that it will absorb a considerable amount of moisture from the air.

The charcoal testing apparatus consists principally of a No. 2 light meter to measure the amount of gas passed through the charcoal, a flow meter to regulate and keep a constant rate of flow, rubber tubing to conduct the gas from the test connection to the meter and from the meter to the small charcoal absorber. This absorber is a tube about 1½ inches in diameter and approximately 10 inches long with a screw cap on one end of the tube and a short piece of copper or brass tubing soldered into the side of the other end to permit the connection with the meter by means of the rubber tubing. Some charcoal tubes are constructed with a screw cap on both ends which necessitates having an extra cap with a small piece of brass or copper tubing soldered through this cap in order to make the connection with the meter. Just above the inlet connection in the charcoal tube is a fine wire screen, the purpose of which is to support the charcoal.

Recovery Expected

It has been determined experimentally that the proper saturation of the charcoal should be such that in the distillation approximately 10 per cent by volume, of gasoline should be recovered. In other words, if the charcoal tube holds 250 c.c. of charcoal, one should recover approximately 25 c.c. of gasoline by distillation. There is a reasonable tolerance allowed in this 10 per cent saturation, which will not affect the final results to any appreciable amount. If the gasoline content of the gas is known, it is very easy to determine the amount of gas to pass through the charcoal to obtain this 10 per cent saturation. If this information is not available, then the amount of gas to pass is usually regulated by the specific gravity of the gas. There is a table available which gives the specific gravities and corresponding amounts of gas to pass. This table was compiled from the average of a great number of tests and in most instances has been found to be very reliable. Of course, there will be cases when it is necessary to run an experimental test in order to determine the proper saturation.

It has been found by innumerable tests that the charcoal test will, in most instances exceed the yield obtained by a physical test car. This applies to gas having a gasoline content of less than 4 gallons per 1000 cubic feet. Above this yield the physical test car will check and often exceed the yield


Air for Aspirator
Ice and Water Bath
3N Rubber Stopper
Pyrex Flask
35 to 50 cc. Charcoal in 1/4 inch Column acting as a Tail Gas Absorber
100 cc Cylinder in Ice and Water Bath
Device to Indicate Pressure of Distillation and to act as Relief

Equipment for making the charcoal test.

obtained by a charcoal test, but the fact must not be overlooked that charcoal being a selective absorbent, the gasoline obtained will be of an unusually stable nature.

When the gas first enters the charcoal tube, there is a noticeable increase in the temperature of the charcoal. This increased temperature is caused by the absorption of the lighter gasoline hydrocarbons which are present in the gas and as the test continues this line of heat slowly rises along the tube, leaving the charcoal, below this line of heat, cool. Sufficient time should be given for the test to allow the dissipation of this heat. It has been found that charcoal will absorb gasoline when the charcoal is 600 degrees F., but the cooler the charcoal, the more efficient will be the extraction of gasoline from the gas.

Records Essential

When the gas first enters the charcoal tube, the charcoal absorbs the fixed gases together with the gasoline hydrocarbons. It is this absorption which causes the increase in temperature as the test continues, the charcoal liberates the fixed gases and retains only the stabler gasoline hydrocarbons. The liberation of the undesirable fixed gases occurs as the test proceeds, thereby causing what is known as a selective absorption.

In completing a test in the field, a record must be kept of the amount of gas passed through the charcoal together with the temperature of the gas, in order to calculate the G. P. M. of the gas tested. The charcoal must now be brought to the laboratory for distillation.

During the first experimental work of charcoal distillation, the gasoline was distilled from the charcoal in the presence of mineral seal oil, because it had been found that a greater yield could be obtained when the charcoal was distilled in the presence of some liquid. Due to the fact that a certain amount of mineral seal oil was distilled over with the gasoline, the results would often be misleading. Another disadvantage was the danger of an excess amount of moisture in the charcoal coming in contact with the hot oil. One instance is known by the writer of an accident where the operator's hands and arms were seriously burned, caused by water dropping back into the hot oil from the end of the condenser tube when the stopper was removed from the hot distillation flask.

Distillation Method

For these reasons it was found necessary to find some other medium to use during distillation. Commercial glycerine was finally found to be very satisfactory for this purpose. Commercial glycerine has an initial boiling point of approximately 550 degrees F. and is not soluble in gasoline. Due to its insolubility in gasoline, the gasoline obtained by distillation cannot be contaminated with the distillation medium, even though some glycerine is distilled over. There is one danger in the use of glycerine. When the glycerine is added to the charcoal there is considerable foaming in the flask. By continual shaking of the flask at the beginning of the distillation, the danger of this foamy mass rising up into the condenser tube can be eliminated. If the proper amount of glycerine is used, there will not be any excess foaming. The amunt to use is approximately 200 c.c. of glycerine for 250 c.c. of enriched charcoal.

Approximately 10 per cent of the charcoal to be distilled is poured into what is known as the second charge absorber and the balance poured into either a 700 or a 1000 c.c. distillation flask. Then 100 c.c. of glycerine is poured into the distillation flask and thoroughly shaken with the charcoal. The flask is connected with the condenser by a copper tubing, if a flask is used which does not have an exit tube. A thermometer is supported through a stopper in the top of the flask and the thermometer bulb is placed about 2 inches below the top of the neck, or where a flask is used having an exit tube, the thermometer bulb is placed about 2 inches below the outlet of the exit tube. The condenser is packed with an ice and water bath and maintained at 32 degrees F. during the distillation. Usually a 100 c.c. stoppered graduated cylinder is used to collect the gasoline condensed during the distillation. The condenser tube passes from the condenser through a rubber stopper into this cylinder and this cylinder is surrounded with crushed ice in order to keep a temperature as near 32 degrees F. as possible.

From the top of this cylinder runs a piece of rubber tubing to what is known as the second charge absorber in which has been placed the 10 per cent of enriched charcoal. The purpose of this second charge is to absorb the gasoline vapors which are evolved during the first stage of the distillation, for of course, the first gasoline distilled over is composed of the lighter constituents and is very hard to hold in solution. The heat under the distillation flask is slowly increased until the temperature recorded by the thermometer is 500 degrees F., at which point the heat is removed. The stopper is then removed from the top of the distillation flask and 100 c.c. of glycerine is again added together with the charcoal from the second charge absorber.

Second Charge

This second charge is introduced into the flask by means of a small paper tube. The stopper is then replaced into the distillation flask and the temperature is again brought up to 500 degrees F. This completes the distillation of the gasoline from the charcoal. It is now necessary to remove the receiving cylinder from the condenser and very accurately measure the amount of gasoline distilled from the charcoal and usually this gasoline is then weathered to 60 degrees F. As a rule there is very little decrease in volume of the gasoline by warming to 60 degrees F. Now it is only necessary to calculate the G. P. M. of the gas tested. This is done by dividing the c.c. of gasoline by the number of cubic feet, at 60 F., of gas passed through the charcoal at the time of the field test, multiplying this result by 1000 and dividing by 3785, i. e., if 25 cubic feet of gas was passed through the charcoal and 25 c.c. of gasoline was recovered by distillation, this would equal 1 c.c. per cubic foot and if 1000 cubic feet of gas had been passed through the charcoal there would have been recovered 1000 c.c. of gasoline. There are 3785 c.c. per gallon, therefore 1000 divided by 3785 would give the fractional part of a gallon for every cubic feet of gas.

In conclusion, I wish to mention the following points in favor of the charcoal testing method:

1. On lean gas, it will give results nearer 100 per cent efficiency of extraction of gasoline from gas, than any other practical testing apparatus.

2. The charcoal testing apparatus is very compact and is readily portable.

3. It does not erquire any technical training to operate.

4. It is operated at a few inches water pressure, thereby eliminating the possibility of erratic results due to leaky connections which often occurs in tests made under higher pressures.

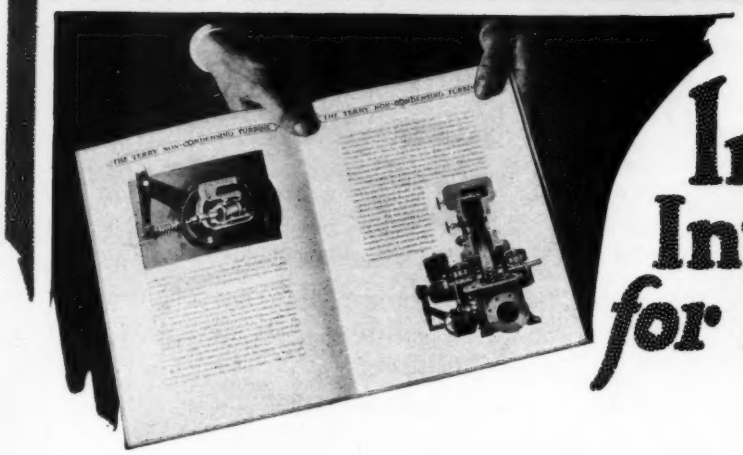
5. A considerable time may lapse between the field test and the distillation test without affecting the results to any appreciable amount.

E. I. Dupont De Nemours Co. Opens Branch in Tulsa

Tulsa, Okla.—Among those attending the convention of the Association of Natural Gasoline Manufacturers held here, April 22-23, were officials and other representatives of the paint and Duco division of the E. I. Dupont de Nemours Company, manufacturers of paints and varnishes for the petroleum and other industries.

P. G. Kennett of Chicago, sales manager of the paint and Duco division, headed the delegation which included H. H. James in charge of the Tulsa offices of the company, E. G. Johnson in charge of the Fort Worth offices and F. H. Crawford of Chicago and E. L. Estes of Kansas City.

The company has established a branch warehouse at Tulsa for the distribution of its products in the Mid-Continent field. During the convention the company had two tank cars on the siding in Tulsa that were finished with Duco paint.



Important Information for Engineers

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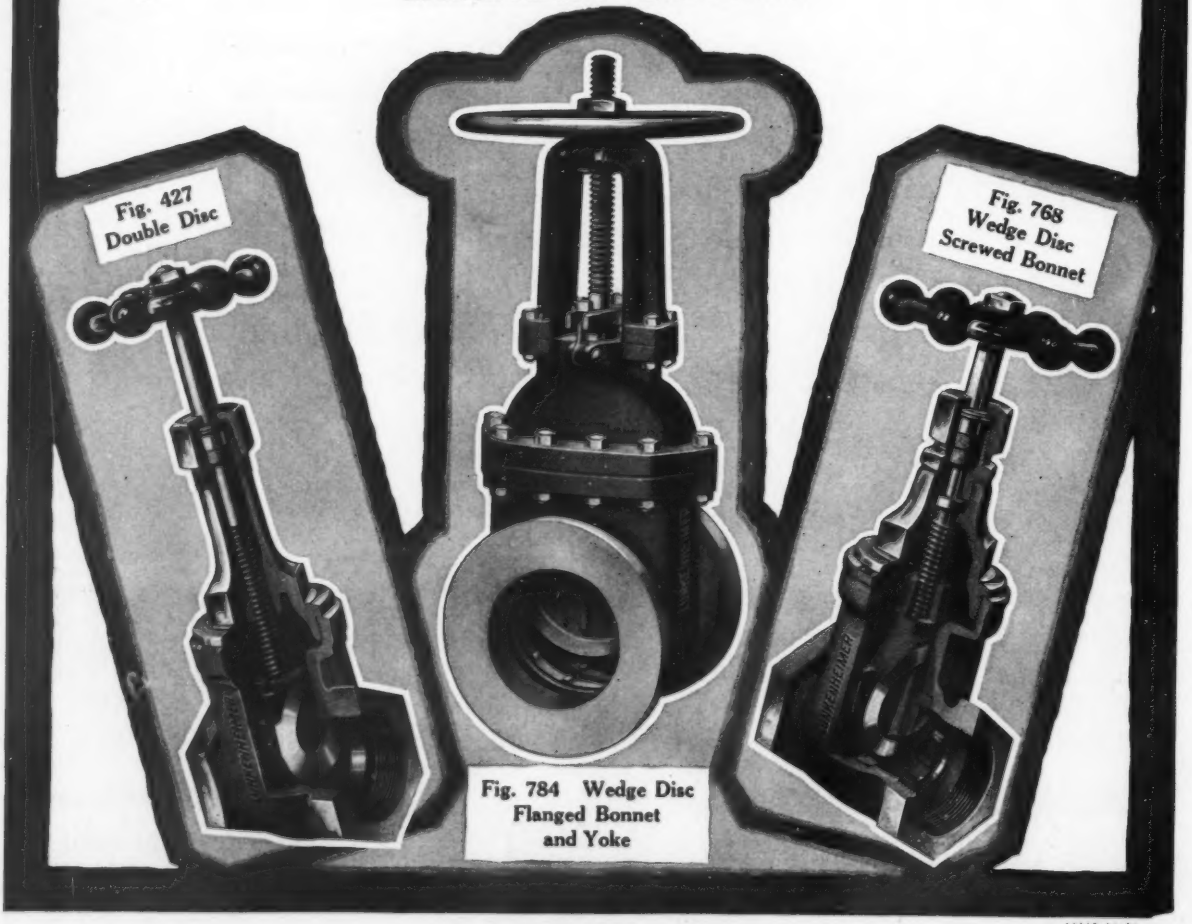

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Finding Gum-Forming Material in Gasoline

Steam-heated oven for maintaining inert atmosphere necessary equipment

By M. B. Cooke,
Associate Refinery Engineer Bureau of Mines

AN ANALYTICAL method for the determination of the gum-forming material in gasoline has been developed by the Bureau of Mines, during a study now in progress to determine the best ways for elimination of such constituents from gasoline. This method is similar in principle to that previously described by Smith and Cooke,[1] which involved evaporation of a sample of gasoline in a small glass dish. The evaporation was started on an actively boiling steam bath and completed in an air oven at 105° C.

In the improved method described below the steam bath has been replaced by a steam heated oven in which an inert atmosphere is maintained. Air is excluded from the oven, consequently the precision of the determination is increased. Furthermore, evaporating dishes different from those previously described may be used.

Description of Oven

The oven used in the present work is double-walled, has glass shelves and a gas-tight door. As shown in Figure 1, steam is admitted by pipe "A" between the walls of the oven. The steam then passes into the drying chamber "B" through small perforations "D" "D_1", "D_2", etc., in the floor of the chamber. These holes are placed near the oven door so that the path of travel of the steam will be across the sample dishes "E", "E_1", "E_2", etc., to the outlet pipe "F". This pipe passes through the outer chamber formed by the double walls, to a trap "G" so placed that the vapors can be led off to a ventilator, while liquids resulting from condensation drain off. The outer chamber is also equipped with an outlet pipe "H" to carry off condensed steam. Valves are placed in the outlet lines so that a slight pressure can be maintained in the oven if desired. It has been found convenient to superheat the steam slightly so that a minimum amount of condensate will form in the inner or evaporating chamber. The glass shelves "J", "J_1", etc., are placed about five inches apart, vertically, so there is working space above the sample dishes.

Method of Making Test

Weighed glass dishes (porcelain or silica crucibles may be used) of 30 c.c. capacity are placed on the shelves in the oven and 20-c.c. samples of gasoline are added from pipettes. The oven is closed and steam is allowed to enter it, the outlet valves being so adjusted that all the condensate is removed and a small amount of excess steam escapes. After two or three hours the steam is shut off, and the oven is opened. The dishes are transferred to a drying oven of the conventional type, and maintained at a temperature of 105° C. for 24 hours. With many gasolines the drying period can be shortened, particularly if the gum content of the gasoline is low. In any event the drying is continued to constant weight. The weight of gum in milligrams multiplied by five gives the "gum content" in milligrams per 100 c.c. of gasoline.

Experimental Data

In order to test out this oven and method, determinations were made on gasolines which were known to contain widely different amounts of gum-forming compounds. (See Table 1.) In most of the determinations better checks were obtained with the oven than with the steam bath, and as a rule the results obtained by oven evaporation were slightly lower.

As already pointed out, in the steam oven the samples are evaporated in an inert atmosphere, whereas in the steam bath some air comes in contact with the gasoline. Smith and Cooke[2] showed that the amount of gum-forming constituents present can easily be increased by passing air through or over the samples of gasoline under examination. This is confirmed by the data in Table 1. When samples were evaporated on top of the steam bath the amount of gum found was always high, as compared to the amounts present when the dishes were placed in the holes in the top of the bath. This difference is due to the fact that dishes placed in the holes are surrounded by steam which leaks out around the dishes and partly protects the contents from air, whereas on the top of the bath there is practically no steam to displace air around the dishes.

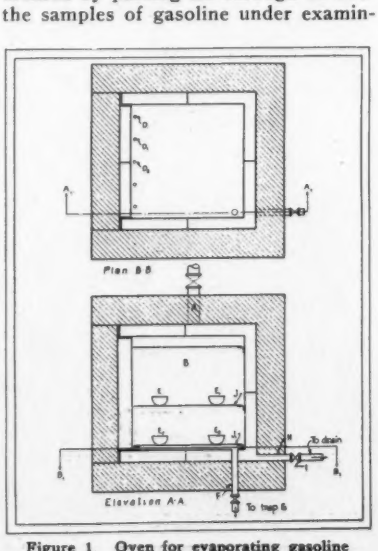


Figure 1. Oven for evaporating gasoline samples.

TABLE 1—Results of Analyses of Gum-Forming Material in Gasoline
(Samples used, 20 c.c.)

Sample	Weight of gum formed— In steam oven	On steam bath	On steam plate
	mg.	mg	mg.
A	7.02	8.0	15.0
B[1]	408.0	494.0	560.0
C	1.7	1.8	3.5
D	5.8	11.0	23.0

[1]Final drying, 60 hours at 105°C. in air oven.

Another advantage of employing a steam atmosphere during the evaporation of gasoline is the practical elimination of "creeping" of the separated gum over the rim and down the outside of the dishes. This is perhaps due to the wetting of the dish by steam, which prevents oil from creeping up by surface tension. When a 20-c.c. sample of gasoline containing more than 50 mg. of gum is evaporated on a steam bath, it is almost impossible to prevent creeping and loss of part of the gum. While some difficulty is found in obtaining check results on high-gum gasoline with the steam-oven method, the variations are evidently not due to creeping, but to differences in the amount of oxidation during the final drying of the gum. For this reason it is recommended that samples of gasoline containing more than 200 mg. of gum per 100 c.c. (40 mg. per 20-c.c. sample) be reduced in volume so that the weight of gum in the dish will not exceed 40 mg. A convenient method is to dilute the gasoline with "gum-free" naphtha, and to take for analysis an aliquot part of the solution.

Experiments with Various Dishes

The 30-c.c. glass dishes used by Smith and Cooke were selected by them because creeping of gum over the rims and sides was less with these dishes than with poreclain and silica dishes. As already stated, creeping is negligible in the steam oven, and 30 c.c. silica, and 25-c.c. porcelain dishes were found to be satisfactory. The data obtained are shown in Table 2. The reason they are satisfactory for use in

[1]Smith, N. A. C., and Cooke, M. B., gum-forming constituents in gasoline, Bureau of Mines, Serial 2394, 1922.

[2]Smith, N. A. C., and Cooke, M. B., work cited.

the oven and not on a steam bath has already been given.

Larger dishes with capacities of 75 to 100 c.c. of gasoline were also tried, but the period of steaming required is three to four times that for the 25 and 30 c.c. dishes. More of the heavy ends of the sample are left in the dish when it enters the air-drying oven, and, as was found in previous work, oxidation of the unstable constituents takes place, giving an increased quantity of gum over and above that found by smaller dishes. The tests with 100-c.c. glazed porcelain dishes gave variable results, those obtained with one dish checked the small 30 c.c. glass dish and there was no creeping, whereas those obtained with another dish on similar gasoline were abnormally low, as the gum crept over all parts of the dish. Apparently the larger dishes are not as satisfactory as the smaller ones. The large dishes used were somewhat flat in shape and exposed a relatively large surface of gum to the air during drying. Possibly dishes of other shapes might prove to be satisfactory.

Summary

1. The improved oven method described gives more satisfactory results for the determination of gum than the method developed by Smith and Cooke (work cited).

2. Evaporating dishes of material other than glass can be employed in determining the gum content of gasoline.

3. The effect of fair oxidation of certain components of gasoline has been shown. By employing an inert atmosphere during evaporation of the samples of gasoline under examination, contact with air is practically eliminated and results are obtained which are believed to indicate the actual weight of gum formed in the gasoline without oxidation.

4. Less time is required for a gum determination by the improved oven method than is required when evaporation of the sample is conducted on a steam bath.

5. Standard conditions can be easily maintained in determining gum by the oven method.

TABLE 2—Effect of Material of Evaporating Dishes

Type of dish used— Material	Size c.c.	Gasoline evaporated c.c.	Gum found mg.	Gum content mg. per 100 c.c.
Glass	30	20	4.0	20.0
Silica	30	20	4.0	20.0
Glazed Porcelain	25	20	4.5	22.5

Absorption Plant Catalog

Braun absorption plants are described in a new bulletin just published by C. F. Braun & Co., Alhambra, Calif. This company has made a specialty of building absorption plants for several years, and results of all their experience are brought out in this bulletin. Copies may be had by writing the company and asking for bulletin 117.

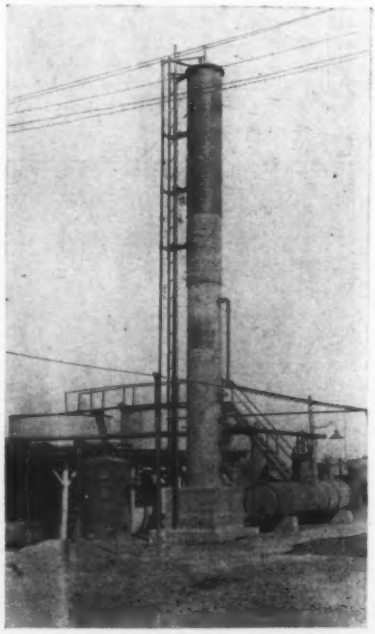
Steam Still Increases Yield From Baffle Tower

By installing a steam still to operate in connection with a baffled tower, the Pure Oil Company has effected a saving of 20 per cent in evaporation over the former method of weathering in tanks. This equipment is functioning at plant No. 2 at Drumright, Oklahoma, being designed by Grover Stout, the superintendent. It was built according to his specifications.

Results of this reduction of evaporation are that it has been possible to shut down two units of the plant and still handle the volume of gas; residue gas for lease use has been increased by 100 per cent. These savings, of course, are due to the fact that the wild gases formerly lost in the weathering process are now either converted into gasoline, or returned to the lease for power purposes.

The tower, as shown in the illustration, is a shell, having a series of baffles through it. The tanks, formerly used for weathering with steam now serve to catch the gas from the cooling equipment. From the tanks the product passes into the bottom of the tower, through a line. As it starts upward, the baffles catch the bulk of it, and it drops back, finally passing out through the line to the steam still, installed beside the tower.

Some of the vapors now dropping back and into the steam still, pass off through the line midway of the tower. These go through the compressors again and are partly converted into gasoline, through the usual methods of the plant. The wilder gases, howeyer, pass on through the tower, escaping at the top and passing into the residue line, where they are carried to the lease for pulling vacuum and pumping wells.



Steam still rigged up with baffle tower at Drumright plant of Pure Oil Company.

The steam still is an ordinary shell, with steam coils, being equipped with Taylor automatic control. The temperature is kept at 90 degrees. From the steam still the finished product passes to tanks.

A report on the operation of the equipment published in the Pure Oil News follows:

"By the use of this equipment, we are able to reduce our plant loss approximately 15 per cent in making a marketable product with 85 per cent recoverey on distillation test and gravity 88."

Aside from the saving through loss of the wilder gases, the process allows continuous operation of the accumulation and stabilizing equipment. In the old method of weathering, tanks were filled, after which the steam was turned in. With the weathering done, the tanks were emptied, they were filled again and the process repeated.

Now, however, the vapors pass continuously into the tanks. They pass on into the tower and there passes out the three courses of the system with no interference. This continuous operation has made it possible to handle the volume of gas with less equipment than was formerly required.

The properties from which the Pure Oil Company draws gas, are all dependent on gas for power fuel. Not enough residue gas was left for all requirements. So a supply had to be bought to make up this deficiency. This cost around $6,000 each month. Since the new stabilizing equipment has been in operation, the cost of extra gas for fuel has been reduced to around $3,000. The wild gases formerly lost in weathering, now pass over at the top of the tower and return to the leases for fuel.

Similar equipment is being installed at other Pure Oil plants in Oklahoma.

L. D. Wyant to Build Plant For Argentine Government

Bartlesville, Okla.—L. D. Wyant, who has been engaged in the refinery research department of the Bureau of Mines here, has resigned and will accept a position with the Comodora Rivadavia Railway Petroleum Company of Argentine, South America.

Wyant will have charge of the construction and operation of a 4500-barrel refinery and two casing head gasoline plants which will be built by that company. This is the first entrance of the Comodora Rivadavia Company into the refining field.

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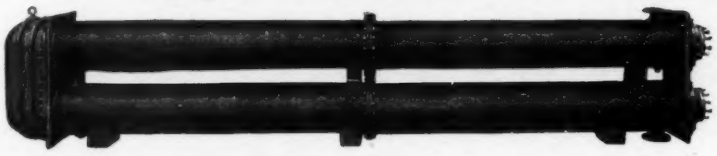

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These advantages and the features of construction of the G-R Mineral Seal Oil Heat Exchanger are explained in Form 207.

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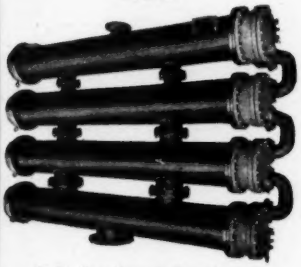

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Silent Characteristics of Fuel Oil

(*Continued from page* 14.)

nited by the automatic control devices. The oil really required by such furnaces is kerosene oil rather than fuel oil or even gas oil.

Pour Point or Cold Test

Another characteristic is the pour point, or as it is often called, the Cold Test. The Pour Point is the lowest temperature at which under the conditions of the test it will flow. As a matter of fact, however, the pour test does not indicate the lowest temperature at which the oil will flow in practice. The test is conducted under strictly non-flowing conditions, while in practical use the oil is subjected to disturbance and to flow and most oils will flow quite freely under these conditions of disturbance at temperatures much lower than the so called pour point. The pour point as determined is only of value in showing at what temperature the oil is likely to fail to start flowing if it has been cooled while perfectly still, as in an unused tank left in winter time over night without disturbance.

Some distilled gas oils contain considerable paraffine wax which raises the pour point, and some residual fuel oils contain so much asphalt in solution as to raise the pour point. Strangely enough an admixture of these two oils of these opposite types often yields an oil of very low pour point. This is due to the mutual solubility of the two solids in each other while they are each in solution in their respective oils.

B. S. and Water

When fuel oil is bought it is of course desired to obtain all fuel oil and no foreign material. Consequently the oil is often submitted to test to ascertain its freedom from water, sand, coke, etc. This test is made by diluting the oil with a suitable solvent and then subjecting the mixture to centrifugal force in an appropriate apparatus.

The apparatus consists of a pear shaped glass bulb with a hollow graduated stem projecting from the smaller end. When the diluted oil in this is subjected to gravity settling or centrifugal force, directed toward the narrower end, the heavier particles subside into the hollow graduated stem, and their volume can be read off.

In theory this looks very fine, but in practice some very serious difficulties and objections arise. These are due mostly to the nature of the solvents available for use for thinning down the oil in order to facilitate the settling of the foreign substances. Naturally the wish is to use the solvent easiest to obtain, which happens to be one of the light petroleum distillates, such as gasoline, naphtha, or kerosene. Unfortunately, however, these petroleum distillates are not good solvents for some constituents of the fuel oil which are perfectly good liquid fuels, and which constituents are in true solution in the fuel oil. In fact, these diluents throw out of solution quite a large amount of these constituents. Benzol is a much better solvent than the petroleum products above mentioned, but even it fails to dissolve certain legitimate constituents of the oil which have high heat generating values. The only diluent easily obtainable that dissolves all the legitimate combustible constituents is carbon bisulfid. This, however, is excluded from use in this test at present on account of its high specific gravity, it being considerably heavier than water.

Benzol Best

As matters now stand, the best we can do is to use pure benzol (this is better than the 90 per cent grade.) This diluent dissolves nearly all the oily and nearly all of the asphaltic matters that are true liquid fuels and leaves undissolved all the water, sand, clay, coke, etc., together with a very small amount of certain kinds of asphaltic matters that are in true solution in the fuel oil, and that are combustible in the fuel oil flame.

A mixture of 4 per cent carbon bisulfid and 60 per cent gasoline has been proposed, but it has no advantage over 90 per cent benzol in solvent power and has the disadvantage of being heavier in gravity than benzol. A blend of 90 per cent pure toluol and 10 per cent carbon bisulfid might make a good diluent, its gravity is not too great while its solvent power is good.

The heavy viscous oily and resinous substances present in residual fuel oils are good solvents for these asphaltic substances and form with them homogeneous liquids, and test methods which condemn any part of the true oil homogeneous solution give misleading results in that they would indicate the presence of insoluble impurities when none such are actually present, or at least would materially increase the apparent amount of these above the true amount present. The same thing is true to an even larger extent in the case of fuel oils from cracked residuum.

As has already been indicated above, fuel oils which are residues from cracking distillation processes often contain asphaltic and even coky particles which in their natural state are highly desirable constiutents of fuel oil. When, however, these constituents are ground so fine in the so-called colloid or other mill that they will no longer settle or agglomerate, they will thus lose all their undesirable features and will help to generate heat units when burned. If now the present ordinary test for sediment is applied to these oils, after thinning with a diluent, these asphaltic and coky particles will be caused to settle out because of the disturbance of the equilibrium in the oil by the diluent. As yet no satisfactory method of testing such oils has been devised and proposed which will differentiate between the detrimental sediment which will clog burners, pipes, etc., and the non-detrimental sediment which will not clog the system, but which forms a part of the combustible liquid.

The light colored fluid oils used for house heating purposes and distilled gas oils of pale or even often of dark color contain none of the asphaltic substances insoluble in the light petroleum distillates or in benzol, and therefore this discussion does not apply to these oils, and moreover these oils do not need a diluent in order to make them thin enough to be subjected to the sediment test to detect and measure foreign matter present.

Water Objectionable

Water, if present in fuel oil, of course is objectionable since it is not combustible and its vaporization in the flame carries away into the stack a certain amount of the calorific energy set free in the combustion. The amount of water present is determined by a process of distillation, in which the oil is first admixed with gasoline, or toluol, and then the water along with the light oil vapors is distilled off, the mixed vapors pass into a water-cooled condenser so arranged that the condensed water and light oil flows back into a trap which catches and retains the water in a graduated tube and returns the light oil to the oil in the distilling vessel. The process is kept up until no more water accumulates in the graduated tube, after which the amount collected is read off.

Gravity

A test in common use for grading fuel oils is that of the gravity of the oil. Naturally the heavier the gravity of the oil, that is the smaller the Baume figure for gravity, the more weight of fuel oil will be contained per unit volume. And since the generation of heat, other things being equal, depends on the weight and not on the volume of the fuel, it follows that heavier gravity fuels are the most economical to buy. Nevertheless, sometimes another factor, namely, convenience in use intervenes and makes it desirable to use lighter gravity fuel oils. This is especially true of house heating oils.

The gravity of an oil is usually determined by immersing a weighted hollow glass spindle which has been graduated according to a standard and reading the depth to which it sinks in the oil as shown on the graduations. Care must be exercised in this operation not to let any oil get on that part of the spindle above the final level of

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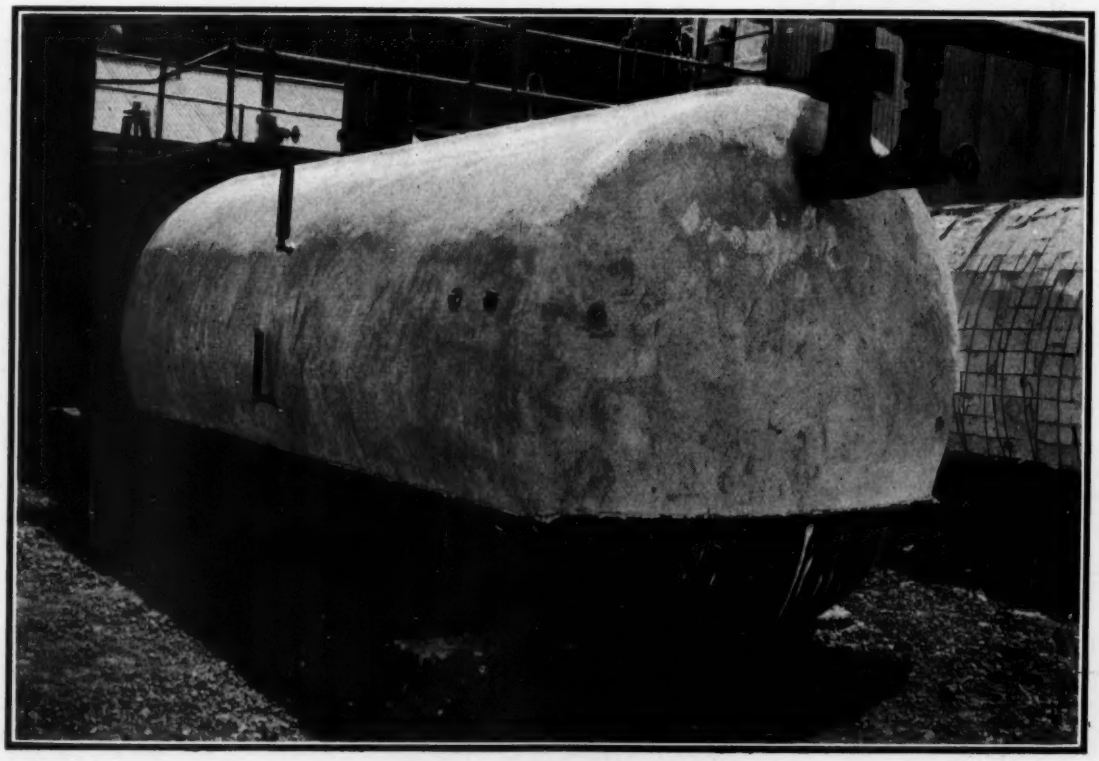

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the oil. In the case of very viscous oils it may take some time for the spindle to sink for equilibrium.

A correction must be applied to the observed gravity reading according to the temperature of the oil, because all petroleum oils have quite high coefficients of expansion with temperature.

Expansion with Temperature

In common with all liquids, fuel oil expands in volume with increase of temperature. Therefore if a quantity of oil is measured at any other than the Standard temperature a correction must be applied to the observed volume at the observed temperature in order to find the standard volume at the Standard temperature. This latter temperature is 60 degree F. and oils measured below that temperature will show a smaller volume than standard and if measured above that temperature will show too large a volume.

Various kinds of petroleum oils show various rates of expansion with temperature but fortunately all American and probably all, oils of the same gravity show the same rate of expansion.

The U. S. Bureau of Standards has recently published a book of tables for making the required conversion for oils of all gravities measured at all reasonable temperatures and these new coefficients and factors should be used for the computation of volume at standard temperature and not the inaccurate methods in use previous to the issue of these standardized tables.

Sulphur

Much is frequently said about sulphur in fuel oil and some users specify certain miximum figures beyond which the sulphur content of their purchases may not extend. Unless there is a solid basis of known fact as to the detrimental effect of sulphur for the particular purpose the fuel oil in question is to be used, such a specification is not to the interest of the purchaser, because it narrows the sources of supply. As a matter of fact all our American oils, except those from the Pennsylvania region, contain appreciable amounts of sulphur, and as the residual oils from the Pennsylvania crudes are of more value as lubricating oils than as fuels, it is comparatively rare that any Pennsylvania fuel oils can be bought.

Many foreign oils are still higher in sulphur content than our American fuel oils.

For burning under boilers sulphur has absolutely no detrimental effect, provided the exhaust gases do not come into contact with iron after they have cooled below 212 degrees F. This is true no matter what the percentage amount of sulphur may be, except that as the heat output of the sulphur content is not very large, this has its effect, though slight, on the heat output of the oil, if the sulphur content is large. For many other purposes also sulphur is equally free from objection.

However, where the fuel oil flame comes into direct contact with certain heated metals, as molten steel, or hot copper, sulphur should be as low as possible because these metals have the property of absorbing sulphur from the flame and this sulphur communicates undesirable characteristics to the metal.

In those cases where the metal is shielded from the direct flame, as in crucibles or in making malleable iron castings, or in case-hardening steel, where the articles being heated are packed in boxes away from direct contact with the flame, the sulphur content of the fuel oil need not be low.

Sulphur also sometimes has a bad effect on the color of some kinds of glass where the fuel oil flame comes into direct contact with the molten glass.

For use in Diesel and semi-Diesel engines, sulphur is not injurious provided the products of combustion are not allowed to cool below 212 degrees F. in contact with any of the iron or steel parts.

In fact the condition for the safe use of fuel oils containing sulphur in all cases lies in avoiding cooling the spent combustion gases below 212 degrees F. in contact with iron or steel. The reason is that the products of combustion of the sulphur are soluble in liquid water, and this solution has a corrosive action on iron and steel. But the hot fully oxidized vapors are without action above 212 degrees F. until a white heat is reached or until the metal is in the molten condition.

Heat Output

Perhaps the most important test to which fuel oil can be subjected is the determination of its heating value. This test is carried out by burning a small weighed quantity of the fuel in a closed vessel filled with compressed oxygen gas. Surrounding this closed vessel is a weighed quantity of water whose temperature is raised by the heat generated by the combustion of the oil. This rise in temperature is carefully measured and thus all the data needed for computing the heat given off by the fuel in burning are at hand. The heat thus generated or set free is expressed in terms of pounds of water raised one degree F. in temperature, and the unit of measurement is called a British Thermal Unit, abbreviated B.T.U. Thus one B.T.U. means enough heat to raise the temperature of one pound of water one degree F. from 63 degrees to 64 degrees F. In the metric system the heat unit is either a small calorie, which is the quantity of heat that will raise one gram of water one degree Centigrade from 17 degrees to 18 degrees C., or a large Calorie which is 1000 times the small calorie.

These can be converted the one into the other by these expressions:

1 (large) Calorie equals 3.968 B.T.U.

1 B.T.U. equals 0.252 Calorie (large).

1 (large) Calorie per Kilogram equals 1.80 B.T.U. per lb.

1 B.T.U. per lb. equals 0.5544 Calorie (large) per Kilogram.

All petroleum oils are mixtures of hydrocarbons of many kinds along with smaller proportions of sulphur containing hydrocarbons, and sometimes small amounts of nitrogen containing hydrocarbons, and occasionally traces of oxygenated hydrocarbons.

In fuel oils the hydrocarbons are all of very high boiling points, as such boiling points go, say at or above 500 degrees F. and usually above 600 degrees F.

Concerning the exact mixture, chemically, of these compounds very little is known and it would not be profitable to discuss that question here. Suffice it to say that fuel oil for our purpose is a compound of hydrogen and carbon in proportions varying somewhat but usually within the limits:

Carbon 89 to 84 per cent.

Hydrogen 11 to 16 per cent.

For oils lighter than fuel oil the carbon may be slightly less and the hydrogen slightly more.

In a general way and with some exceptions the amounts of carbon and hydrogen present in any particular distillation fraction, or cut as it is popularly called, of petroleum will differ roughly with the boiling point of the oil. Thus, roughly the lower boiling point and the lighter the gravity the more hydrogen will be present relatively to the carbon, and vice versa the higher the boiling point the higher the carbon relatively to the hydrogen.

This is one of the reasons for the variations in the amount of heat generated per unit weight of oil. Other reasons for these differences reside in the internal structure of the oil molecule, a subject that will not be entered into here.

When a unit weight of hydrogen burns in air or oxygen it develops enormously more heat than the same unit weight of carbon does. Thus:

Carbon (coke) generates 14,500 B.T.U. per pound.

Hydrogen (gas) generates 62,000 B.T.U. per pound.

It follows from this that those oils which contain more hydrogen relatively to the carbon will develop more heat units during combustion than those oils which contain more carbon relatively to the hydrogen. This is a broad factor involving all petroleum oils, not simply fuel oils. But it must be borne in mind that it applies to weights only. If we consider volumes instead then the relative specific gravities of the oils also come into play and this factor is dependent not only on the relative percentages of hydrogen and carbon, but also, and this to a large extent, on the degree of molecular condensation of the hydrocarbon compounds involved.

The following table which is approximately valid for Mid-Continent fuel oils will show the way in which these facts dovetail and the results in heat units developed on combustion.

JENKINS CRACKING PROCESS

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Any cracking operation will form some carbon. But why accentuate this condition by forming greater amounts than necessary and why transform all carbon into coke?

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Table of B. T. U. developed by Fuel Oils of Different Gravities

Gravity Baume	B. T. U. per lb.	Lbs. per Gal.	B. T. U. per Gal.
10	18,650	8.32	155,170
15	18,850	8.04	151,550
20	19,050	7.78	148,210
25	19,250	7.53	144,950
30	19,450	7.29	141,790
35	19,650	7.07	138,925
40	19,850	6.86	136,170
45	20,050	6.66	133,530

This table shows clearly that in spite of the fact that in general the lighter oils contain a higher percentage of hydrogen, which increases the heat units per pound evolved on combustion, the less actual weight per gallon of these same lighter oils much more than overbalances this increase, so that there is an actual decrease in units per gallon evolved on burning the lighter oils.

These figures are shown graphically on the accompanying chart. The two curves are drawn to the same scale so as to bring out these differences. Notice the curve of change of heat of combustion with gravity, per pound, has but a very gentle slope. This signifies that the difference in heat output per pound differs but little between oils of different gravities. Notice also that the curve of heat output per gallon is quite steep, which signifies that the difference in output per gallon differs considerably with oils of different gravities.

Notice also that these two curves slope in opposite directions, which indicates as already explained that the change in output of heat of combustion varies in opposite directions according to whether the oil is burned by weight or by volume.

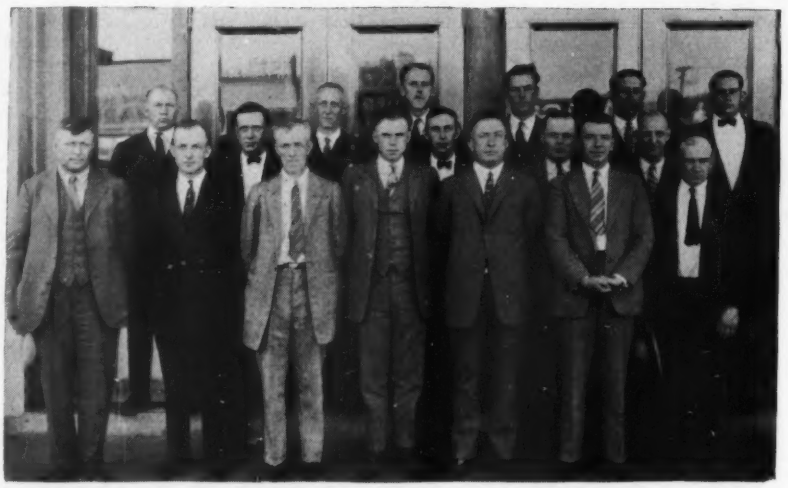
Miscellaneous

Various other characteristics may be examined by special tests where the fuel oil is to be used for special purposes. Thus the carbon residue has been proposed as a test for Diesel engine fuels, but apparently there is no definite relation between the amount of carbon indicated by the usual mode of making this test and the usefulness of the oil in these engines.

A fractional distillation test of the oil has also been proposed by which to ascertain something about the relative volatility of the different fractions, but this test also has failed to yield useful results for the evaluating of fuel oil.

Conclusion

The various characteristics of fuel oils have been discussed here not because it is necessary to test them for all these properties, but in order to bring before you the characters involved. As far as testing is concerned, the number of requirements should be made as small as possible so as to admit the greatest number of oils possible and thus widen the sources of supply without any detriment to the useful qualities of the oils obtained.



Back row: P. R. Lemley, Sallyards; Henry Chamberlain, Bartlesville; H. A. Ells Thrall; F. R. Quast, Burbank; H. L. Oder, Bartlesville; J. W. Wilson, Tallant. Center row: J. H. Porter, Jr., Caney; E. H. Schoenfeldt, Bartlesville; R. T. Powers, Bartlesville; S. B. Crooks, Bartlesville. Front row: Ira Cunningham, Covington; E. C. LeFevre, Bartlesville; M. C. Veley, Okemah; Margon Walker, Seeley; E. L. Peck Bartlesville; G. M. Davidson, Bartlesville; Dick Rodgers, Bartlesville.

Superintendents In Conference At Empire Offices

A general meeting of the Empire Gasoline Company was held in the Bartlesville office on Wednesday. Superintendents of the various plants of the division in Kansas and Oklahoma, were present.

E. L. Peck, manager of the division, was in charge of the morning meeting and H. R. Straight, vice president and general manager of the Empire Companies, Floyd C. Brown, assistant general manager, and T. P. Steeper, assistant secretary, spoke to the men.

Mr. Straight described the economic conditions of the country, explaining the business conditions today and what is expected in these circles the rest of the year. He also talked of the company's sound position and of the operations of the various divisions.

Floyd C. Brown urged the men of the importance of economy of operations. Mr. Brown pointed out to the superintendents the importance in use of warehouse materials and adapting the materials to use on the properties. He also advised the men to increase the practice of repairing equipment rather than throwing it aside and ordering new equipment.

Mr. Steeper related to the visiting plant superintendents and other members of the gasoline division, the plans of the customer ownership campaign. He stated that the preparations for the campaign were well under way and from the interest displayed by the employes in the sale of securities, the coming campaign would be more successful than any other conducted by the Empire Companies.

In the afternoon G. M. Davidson was in charge and the entire period was spent in discussing operations of the division. Round table discussion of operation problems were conducted by Mr. Davidson, and R. T. Powers followed him with a talk on plant ledgers and miscellaneous work orders. S. B. Crooks gave some instructions to the men on plant reports and forms to follow in making the report.

Gasoline Contract Made

Toledo, Ohio.—H. R. Singleton, general manager Paragon Refining Company, Toledo, Ohio, has closed contract for the shipment of 3,000,000 gallons of gasoline monthly. Shipments will be made by water route over Lake Erie and through the Erie Canal to New York. First shipments start next week and four trips a month will be made, and the Eastern buyers expect to increase the shipments to 5,000,000 gallons monthly.

The Paragon plant is being overhauled and additional still constructed and when completed will handle close to 15,000 barrels of crude daily.

Receivership Asked

Wichita Falls, Texas.—A voluntary petition in bankruptcy was filed in United States district court here May 25 by the Griswold Oil Corporation, which is operating a refinery at Electra, and has pipe lines connecting its Wichita-Archer County producing properties. According to Eugene F. Griswold, president of the Griswold Oil Corporation, liabilities are listed at $607,088.58 and assets at $718,666.85. Walter Nelson has been appointed special referee and D. J. Gray, formerly with the Texas Pipe Line Company, is receiver.

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The thin, hard, coke-like scale which forms in pressure still tubes is a severe test for tube cleaner cutters. Only cutters which are hardened and heat-treated in exactly the right manner can hope to be successful in this service.

Liberty cutters are case hardened and tempered with the utmost precision, tested under conditions of complete uniformity. Liberty cast iron drill heads are cast integral with the studs and carefully hardened. Years of experience are back of the exact heat treating procedure which produces hard, sharp cutting surfaces with great strength and toughness.

Put these sharp teeth to work for you. Liberty Cleaners will cut out the hard coke deposits from your still tubes and cracking coils in minimum time and cost.

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Our extensive facilities for the production and transportation of Liquid Chlorine enable us to give the best of service to all refiners using our process. We also produce and market direct to the petroleum industry the following standard chemicals: Caustic Soda, in solid form and in tank cars of liquid solution of any desired strength up to 50% Sodium Hydroxide; Bicarbonate of Soda, for all foam type fire extinguishers; Bleaching Powder, sometimes used in making up hypochlorite solutions; Soda Ash, Anhydrous Ammonia and Aqua Ammonia. Quotations and shipping points gladly given on request.

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Factors of Underground Water Sources

Direction of flow, spacing of wells, porosity of sand and dip demand consideration

By Harry Pennington
Mechanical Engineer

THIS article deals with underground water and its recovery in quantity. While conditions surrounding the accumulation of ground water differ in various localities, the subject matter will hold good generally for ground water recovered from sands.

Any water supply in contemplation necessarily requires analysis with reference to hard and soft scale forming solids and salts before any further work is done toward development. If the best supply obtainable is hard, a water softening plant can render it usable in boilers with a lower plant operating cost than with hard water as found. But water with an excess of salts cannot be treated to make it suitable for boiler feeding; no commercial treating process has yet been devised that will handle salts in water for removal or rendering harmless.

The carbonates form soft scale forming solids; the sulphates, hard scale forming solids; salts make the boiler foam. In searching for a water supply, these should be fixed at a maximum and any water above this rejected as a possible source.

Ground water accumulations in sands are from water percolating into the sand and flowing down the dip. Percolation may be directly into the sand at its outcrop or, if the sand is shallow in depth to it from the surface, water may percolate directly down to it through upper porous layers. And, when the sand is underlaid with an impervious bed of some kind, as clay for instance, the sand then constitutes a reservoir through which water flows.

It might be well here to divide ground waters into those found deep and those shallow along the lines that the deep sands cover wider areas and are well known, while the shallow sands containing water are more or less local and more difficult to find.

The deep sands from which water is recovered may be illustrated by the Trinity, Paluxy and Woodbine, of North Texas: the Dakota of the upper Mississippi Valley and the Artesian Belt sands of the Gulf Coast. The outcrop of the Trinity Sand being about one hundred and twenty-five miles west of Fort Worth and the dip southward and eastward, the depth at Dallas is about 2800 feet and the sand is about 150 feet thick. The outcrop of this sand is expressed in large areas covered by sand such as those found at Desdemona. These sand beds receive rainfall with very little run off and water so accumulated travels down the dip. The surface elevation being greater at the outcrop than at Dallas, wells in this sand flow large quantities of water initially.

In its travel through the sand, this water dissolves the cementitious material from the sand, lime, and the water is rather heavily charged with solids, although these are removed quite easily by softening plant.

Local sands are those covering a small area; these are of importance in that they may furnish a supply where waters found lower down are not suitable for boiler use. There are some districts, as in the Wichita Falls country, where waters found at a depth are highly mineralized and unsuitable, but where shallow waters may be found in quantity that are suitable.

These shallow waters, and I mean by that, waters found shallower than 100 feet usually accumulate in and follow natural drainage lines; the water shed of a small steam bed may have a surface layer of porous material that will gather water, deliver it into a lower sand, whence the water may travel down the dip and the location of a station at a correct point may recover such waters. The writer has built a number of such plants along these lines, successfully operated for years. These waters usually do not have an opportunity to become mineralized, though there are salt beds in some places that charge the waters passing through, particularly in those localities where the geological formations are such as to have tended to mineralization during the time of deposition. The Permian is such formation.

As a general proposition, underground water is always in motion, flowing down the dip of the stratum containing it, and all water may be traced to its source and its accumulation there explained. We are not dealing with geology, but with the mechanics of fluid in this discussion.

The direction of flow underground may be obtained by ascertaining the static level of water in three wells located, say at the points of an equilateral triangle. Three wells are necessary because one defines a point, two a line and three a plane, and when the levels are referred to a common datum plane, the direction of flow is evident. Velocity may be directly measured, and because underground velocity is a measure of the supply, it necessarily should be measured. This may be done by taking two wells along the line of flow as indicated by the levels. By pumping brine into the upper well, the rate of flow to the lower well may be measured by immersing a galvanic couple in the lower well and connecting it with a mirror beam galvanometer. This may seem to be a useless refinement but investments in wells, pumps, engines and pipe lines may be such that to make positive assurance that the required quantity of water can be obtained is necessary. This work would require three or four days, and refers to shallow waters; the deep waters are usually well known.

In the design of plant, the writer has proportioned them so that the daily withdrawal does not exceed the replenishment from flow underground, so as not to draw upon the reservoir capacity of the sand. This is evidently a measure that will insure permanency, for to draw so heavily as to deplete

(Continued on page 37.)

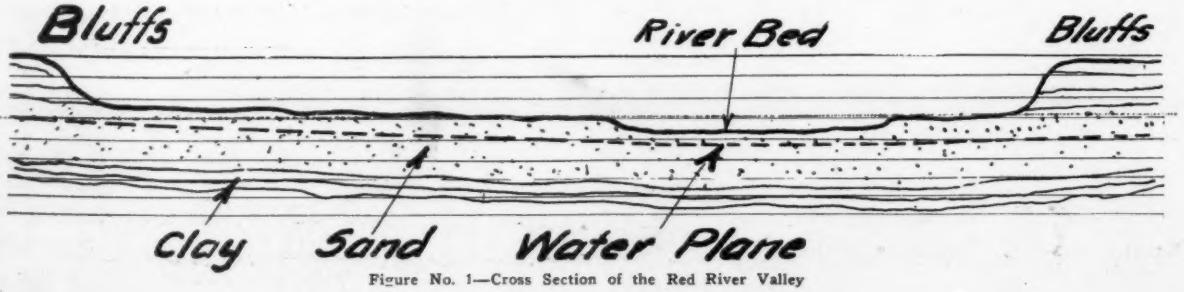

Figure No. 1—Cross Section of the Red River Valley

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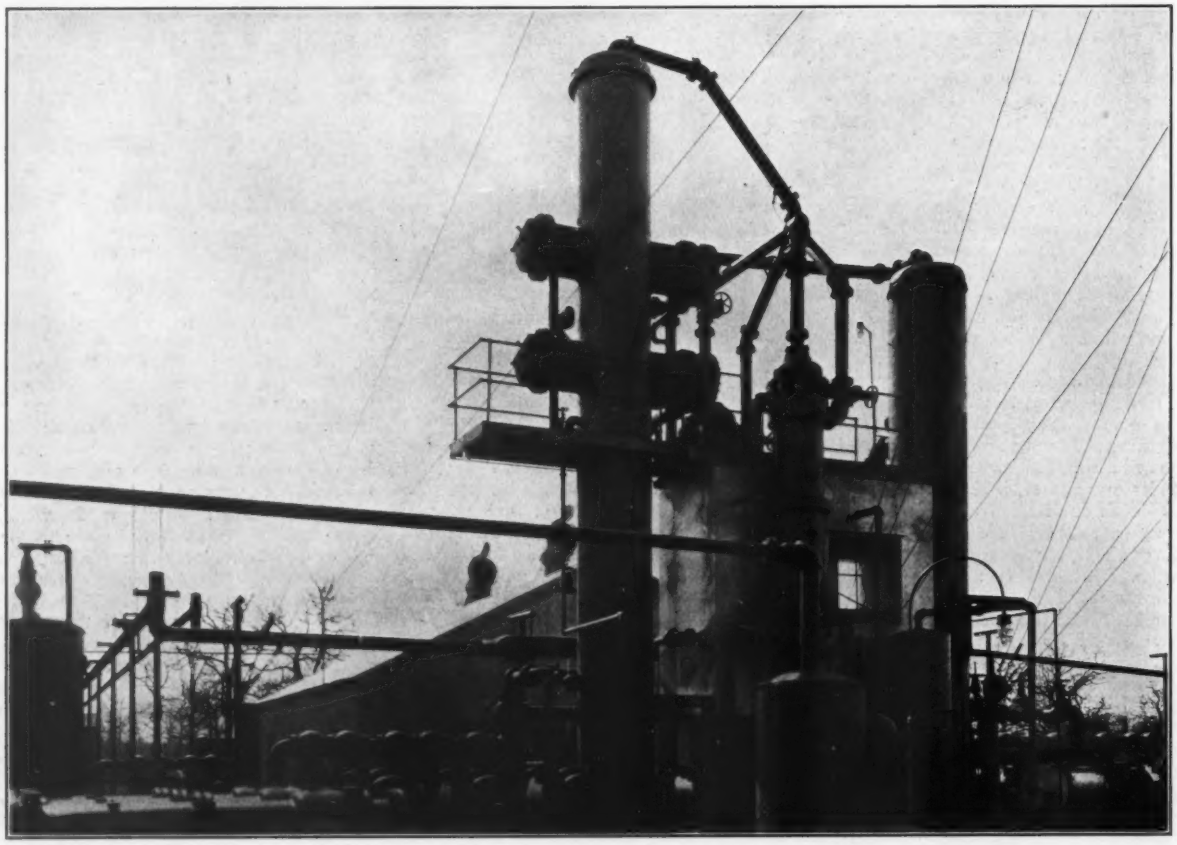

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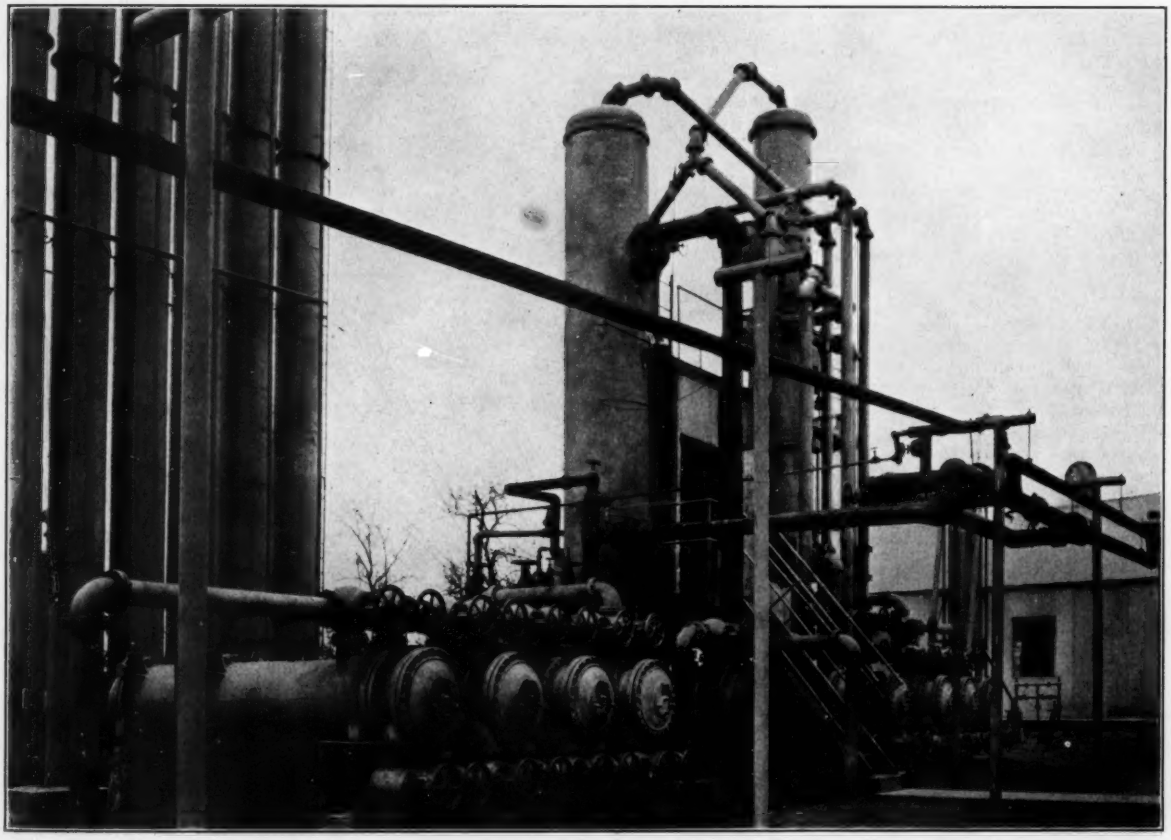

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Hot Oil Affects Tank Contraction and Expansion

Los Angeles, Calif.
The Refiner and Natural Gasoline Manufacturer,
Houston, Texas.
Gentlemen:

I have been a subscriber to your magazine for two years, and find in it much information and matter of interest. While you do not carry a regular "question and answer department" as some of the petroleum journals do, I have heard that you will attempt to answer questions concerning the oil industry if you have the information at hand.

A question upon which I have tried to obtain certain information for a long time is this:

"Give a cylinder (in this case metal) whose walls are of appreciable thickness and whose height does not exceed its diameter. Will the top of this cylinder contract, or rather is there a tendency for the top to contract if the bottom is expanded radially? Can this be proven from a consideration of stresses and strains as a problem in mechanism? In the case of a small rubber cylinder, a piece of hose for example, if the bottom be enlarged with a cone it is evident to the eye that the top does contract."

The problem finds application in possibly explaining the contracting and buckling of the top rim of a tank into which hot oil was pumped. The hatch was wide open and there was no chance of pressure or vacuum being the cause of the buckling. It was thought that perhaps the bottom of the tank cylinder was expanded by heat and caused the top to contract. Have you ever heard of similar incidents of this kind? If you can refer me to any text book of mechanics where the above problem is demonstrated, or if you can give me any definite information that the top of a cylinder does (or does not) contract when the bottom is expanded, I will be greatly obliged.

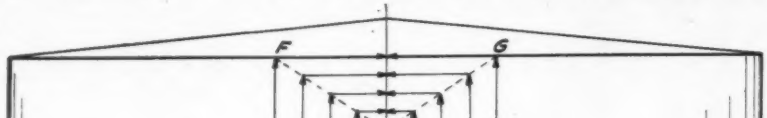
Thanking you in advance for a reply, I am, Yours very truly,

E. W. Crell.

Hot Oil in Large Steel Tanks

Distortion of tank plates, set up by unequal expansion caused by hot oil being pumped in, may be shown graphically after obtaining the amount of linear expansion due to temperature and the forces set up by expansion.

The expansional coefficient for soft steel, such as used in tank plates, is .0000061 per degree difference in temperature Fahrenheit. If the temperature of the atmosphere and of the tank sheets is, say 80 F., and oil at 160 degrees F. is pumped in, the rise in temperature of the sheets will be 80 degrees, less radiation, which will be omitted for simplicity. In a 55,000-barrel tank, with a diameter of 115 feet, the circumference is 361.28 feet, and multiplying by the coefficient and then by 80 degrees, the linear expansion is 2.115 inches, which is uniformly divided or should be, around the circumference.



Assuming further that the tank is 30 feet high, six rings, each five feet high, with the bottom ring 9/16 inch, the next ring ½-inch and the top ring ¼-inch, and setting up a vertical at any point on the circumference, considering for the moment that the force of expansion is concentrated at this vertical, we have the force polygons shown in Fig. No. 1. With the tank pumped one-third full of hot oil, expansional forces are set up for a distance of ten feet from bottom. The bottom ring, with a cross sectional area of the sheet of 33.75 square inches and the next ring with a cross sectional area of 30 square inches, is a total of 63.75 square inches of steel that expands. Since the compressive strength of steel is about equal to its tensile strength, and tank plates have an average tensile strength of 50,000 pounds per square inch, multiplying 63.75 by 50,000, the result is 3,187,000 pounds force exerted by the expanding steel and an equal resisting force would be required to prevent linear temperature expansion. Since no such resisting force is present in the tank structure, the sheets expand freely when heated oil is pumped in, setting up the forces shown graphically in Fig. 1. The analysis considers the tank wall as a whole without reference to riveting.

The lower two ring sheets being heavier than the third ring, the third ring can not resist the forces set up by the expanding two lower rings. While the graphic analysis shown does not exactly represent the directional forces, it suffices for this purpose, being simple and easily grasped.

When the section CD elongates from temperature expansion, the section CDO is placed in tension and the section FGO in compression, when FG then becomes a column. Since the top sheet, represented by FG is thin, usually ¼-inch, its 1/r ration is such that it deforms very esaily under compression because of slenderness, and may buckle inward or outward. Outward buckling could do no great harm, but, taking a chord representing the buckled section, the inward buckle would be equal to the depth of chord plus the added temperature buckle which is serious.

If the top ring is secured by a binding ring, and in turn braced securely by rafters, so as to develop the column strength of the top ring, the sheets would simply buckle outward.

The tank bottom also sets up unusual forces due to temperature expansion, that tend to buckle the top rings. With a diameter of 115 feet and a rise of 80 degrees, the bottom diameter increases to 115.056 feet. Usually the bottom buckles upward until oil pressure flattens it again.

It can be shown by analytical geometry that as the diameter of a tank increases, the arch effect of wall decreases, until it finally disappears and the tank wall then must be considered as a straight wall. There is little arch effect remaining in the wall of a 115-foot diameter tank to resist inward buckling of plates.

To the above forces should be added the usual stresses in a circular tank wall, due to horizontal pressure of oil. This may be computed by using Janssen's formula for converting horizontal pressure into tension in which:

$$T = W \times \frac{D}{2}$$

in which T equals circumference tension in a strip one foot deep, D equals diameter in feet and W the weight of one cubic foot of oil. Solving, the tension set up in the steel plate by oil pressure alone is not sufficient to cause elongation of consequence to the subject in hand because the plates are heavier than required to resist elongation from tension, being made thicker to have a self-supporting structure to resist wind pressure when empty, although, if you wish to complete this calculation, Hooke's Law, viz., unit stress varies as unit elongation, applies, using Young's moduli, which in this case is 29,000,000 pounds.

Almost any work on theoretical mechanics or applied mechanics and strength of materials gives the foregoing formulae and we have tried to bridge the gap between text and practice in this explanation.

The answer is not to pump hot oil into a large steel tank. As a continuous practice it would be preferable to cool the oil in a heat exchanger not only to prevent damage to tank, but to recover the heat in the oil and use it.

The foregoing applies to concrete tanks as well as steel. Concrete oil tanks may be damaged more than steel.

Factors of Underground Water Sources

(Continued from page 33.)

the water content means eventual exhaustion of reservoir capacity and a reduction of plant capacity to that of the replenishment anyway. From which it seems that measurements of velocity are quite necessary to the correct solution of such water problems.

Underground velocities vary widely, depending upon the slope of the stratum and upon the porosity. The writer has measured velocities as high as five hundred and seventy-five feet per day, through gravel, down to as low as eight feet per day in fine sand.

Many river valleys have an under-

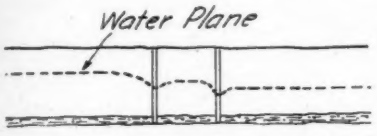


Figure No. 2—Interference of wells along line of flow

ground water sand that can afford large quantities of water that is of different origin from that in the river and, in some cases, the stream bed even may be dry except at flood times. Some of these are the Rillito in Arizona with a dry stream bed; the Arkansas River in its upper reaches in Kansas and Colorado, where the flow is variable and sometimes not at all; Red River; the South Fork of the Platte; and others.

A typical cross section is shown in Figure No. 1, which is across Red River in Wichita County, Texas. At this point, the river has no surface flow, but the sands of the river bed contain highly mineralized water flowing slowly down under the river bed. Where the waters flowing into these river bed sands from the sands away from the river, meet the river waters, a line is marked of potable water and of salt water, and the recovery of usable water therefore became a problem of intercepting the flow toward the river, because to draw upon the reservoir capacity of the sand meant that salt water from the river would enter the system.

Since all water underground is in motion, unless a barrier of some kind prevents, it follows that a recovery line of wells would be located arross the line of flow, rather than along the line of flow, or scattered indiscriminately over an area. When two wells or more are located along the line of flow, interference is set up, shown in Figure No. 2. The first well lowers the water plane, necessarily, to withdraw water in given quantity, and the second well cannot withdraw as much as the first because of this depression.

And, when the wells are too close together across the line of flow, interference is also set up, although when the sand is fine, closer spacing may be necessary.

An example of a line of wells across the line of flow is at the Alta Loma Air Lift Pumping Station, Texas, which supplies water for Galveston, although this is a larger plant than usually required for refinery and gasoline plant work.

The normal direction of flow is southeast; the line of wells is 17,300 feet long; and there are thirty wells. The possible recovery of water from these wells is 15,000,000 gallons per day, although the city does not require that much. The air lift pumping station, designed by the writer and constructed under his supervision in 1909 has furnished a continuous supply.

Every well has a definite static head or fluid level. When water is withdrawn by pumping, the level lowers, due to friction of water traveling toward and up the well bore, the static head lowers, and a direct measurement of this may be had by ascertaining the depression of static head with a given delivery of water. For instance, if the head lowers 100 feet and the level depresses 50 feet, when the well is delivering 100 gallons per minute, the depression factor is two, or, for each foot of depression, the water level lowers two feet. Then, when the head is lowered 100 feet, the delivery will be 200 gallons per minute, less a small amount due to higher velocity setting up frictional resistance. This well factor, though, holds fairly constant.

To say that a well delivers 50 gallons per minute is not usually a measure of its performance, or a measure of quality of the workmanship of making the well, but a free flowing well is always indicated by a low depression factor. And a guarantee of water supply, without any guarantee as to the depth to which pumping must be done is an inadequate guarantee, because to get the water it is only necessary to go deeper and pump more with the pump set lower down.

In many applications of well factors as outlined above, possible deliveries have been ascertained and pumps set by the well factor to secure the necessary quantity, although, when doing this, the quantity obtained should not draw upon the reservoir capacity of the sand, else the pump will have to be set continually lower and lower to maintain the supply. Additional wells in such case would be the better procedure, for securing a permanent supply. The depression factor, applied to wells by the writer in 1904, is quite an important gauge that may be applied to wells, either oil or water, since it is a direct measure of the free flowing qualities of a sand and workmanship.

The depression factor depends upon:

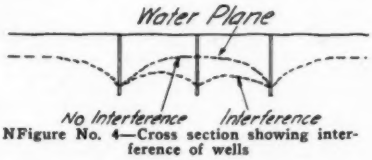
The porosity of the sand formation;

The dip and difference in elevation between the outcrop and the well mouth and the consequent hydraulic gradient from outcrop to entrance into the well bore;

The method employed for separating the water from its sand reservoir.

When these factors are obtained for each well in use and comparisons made, beyond doubt some of them will be found furnishing water at lower cost than others, due to variation in well factor and those with high costs may be re-conditioned.

Also, these factors are necessary at all times to the maintenance of a sys-



NFigure No. 4—Cross section showing interference of wells

tem of wells; the finishing of a well may be classed as good or bad by this factor; the condition of a well can be observed continuously and when the factor lowers so that it indicates the well is getting in bad condition, suitable remedy may be employed.

Whether a sand is fine or coarse, the porosity may be the same; although the pore spaces in coarse sand are larger, they are not so numerous as those in fine sand. Porosity depends upon the uniformity of sand grains. If all the sand grains were spherical and uniformly of the same diameter, the pore spaces would be 47.6% whether the grains are large or small. Low porosities are due to graduated grain structure, the smaller particles filling the spaces between the larger and porosities therefore range from 12½% to 35%, so that the water content may be from 12½% to 35% of the sand volume.

And, taking the area of a cross section of the sand stratum across the line of flow and the porosity, the average quantity of daily flow of water may be estimated, when the velocity is known.

Not all of the water from any sand is recoverable because capillarity and adhesion prevent. And because capillarity is greater in small spaces than large, it follows that fine sands do not permit as great recovery as coarse. For instance, take a quart measure of sand passing through a 30 mesh screen and another quart measure of sand passing through 60 mesh screen. Pour-

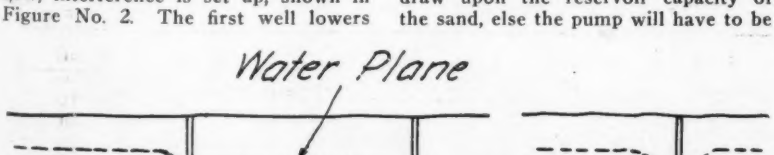


Figure No. 3—Wells along line of flow and at right angles

ing in water until each measure of sand is submerged, then opening a hole at the bottom of the measure, more water flows from the 30 mesh sand than from the 60.

Since all sands have silt, fine grains and coarse, it follows that these may be handled adjacent to the well in such a way as to increase the porosity, which allows free flow to the well and also maintains the well in condition. By drying out a measure of the sand, then screening out the successively coarser fractions, using cement screens, and then fixing the mesh of the strainer so that from 30% to 35% will pass through the strainer meshes and out of the well with the water, the sand will then have its maximum porosity established in a zone surrounding the well. When water flows to the well, it carries with it the silt and small grains, which migrate through the pores between the larger grains to the strainer. If the strainer meshes are too small, these smaller particles lodge against the strainer and build up a non-porous or low porosity zone around the well bore, presenting a barrier to the flow of water into the well, whereas, if these finer particles can pass through a properly proportioned strainer, the pore spaces at the face of the strainer will not clog, and a zone of high porosity is established around the strainer that permits free flow into the well, because the pore spaces then can remain open and deliver water effectivcly. The writer has visualized this in the laboratory.

The principle of removing the finer particles has been used for years; the discovery that additional particles of fine sand migrate to the well bore was made by the writer in dealing with the accumulation of paraffin in oil wells and in removing the same for securing greater percentages of oil.

Well factors are increased materially by painstaking attention to the open pore spaces phase and many instances can be named of well failures due to closing of pore spaces.

When the zone around the well clogs, the well factor is low and continues to lower, although the well may not be drawing upon the reservoir capacity of the sand. And therefore, the distinction must be made between low well factors caused by a clogged well zone and low well factors caused by drafts too heavy for the normal flow in the sand to replenish.

Strainers will also clog from accumulations of scale, even in waters of the better class. Scale seems to collect in close places and, since strainer meshes are usually fairly close, closing of the meshes also lowers the well factor. Closing of the meshes by scale is a gradual process and it may seem that the supply is failing. It is seen then that every well should be so constructed that the strainer may be readily removed and cleaned or another strainer secured and placed in the well so as to avoid the expense of a new well.

When a well is first drilled and finished, and quantities of sand are necessarily pumped out to clean the zone around the strainer, or develop the well, the air lift is a convenient method of handling such sand bearing water.

Contiguous wells interfere with one another when the withdrawal rate of water is beyond the capacity of the sand to replenish. When a well begins to deliver water, it establishes a depression locally of the hydraulic gradient and of the static head around the well. The depression has been termed the circle of influence but the writer has found that the influence area does not take circular form but is modified by the hydraulic gradient and by the velocity of flow, so that the area of least depression is on the up dip side and the area of greatest depression on the down dip side, which is but a natural occurrence. When the wells are located so that the depressed areas overlap, we have well interference. The degree of interference varies with each well, depending upon the distance apart, upon the location with reference to the direction of flow, upon the well factor, upon sand porosity and upon the quantity of water withdrawn.

Let it be here understood that no two wells have the same depression factor; factors are individual to each well; the writer has never seen two wells with the same factors, consequently, each well must be gauged to ascertain its depression factor.

Figure No. 3 shows the water plane of a well drawn exactly as measured; the section at the left of the figure shows the water surface along the line of flow, where the water level in the sand is highest in the direction from which the water is coming, and naturally, the level is higher than that down stream, below the well. The right hand figure shows the same well, without interference from other wells, at right angles to or across the line of flow.

Figure No. 4 shows the effect of interference as measured by the writer. The two outside wells had very little interference at the rate of pumping, but when the third well was placed between, then all three interfered. The result was not three times as much water as one well but two and one-third times as much.

Thus, we can see that the location of wells has more to do with properly finished wells than any other factor; if wells are located along the line of flow, they interfere materially; the supply appears to diminish, pumping costs increase and drilling of new wells must be done to maintain the supply.

All of these factors are subject to fairly accurate measurement and computation; any water supply from wells in sand must be laid out with reference to the controlling factors of wells if the supply is to be maintained constantly without new wells.

The diameter of wells may be fixed by the capacity of the sand. The cost of drilling and casing wells increases approximately as the square of the diameter. While the cost of drilling does not increase in such proportion, the cost of casing increases more, due to greater wall thicknesses of the larger sizes.

Then, when a certain quantity of water flows daily through a sand, permitting a definite recovery of water

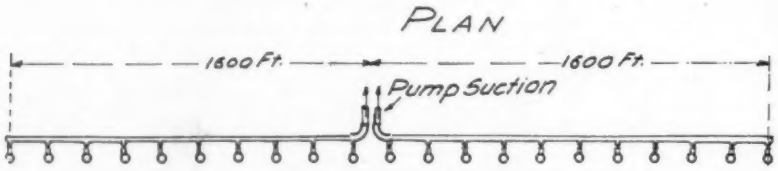


Figure No. 5—Plan of development of shallow wells

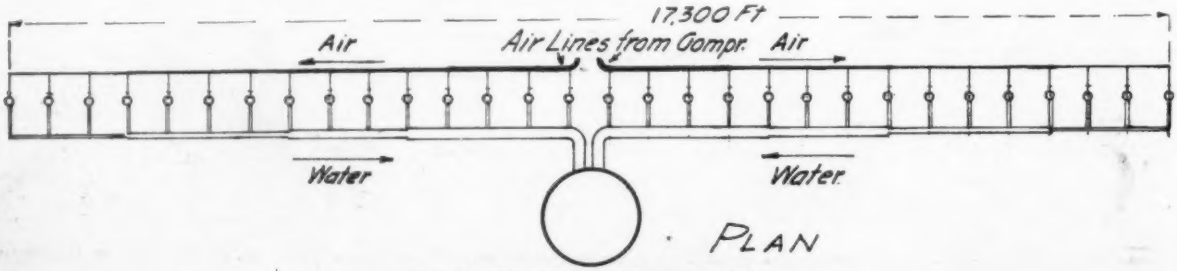
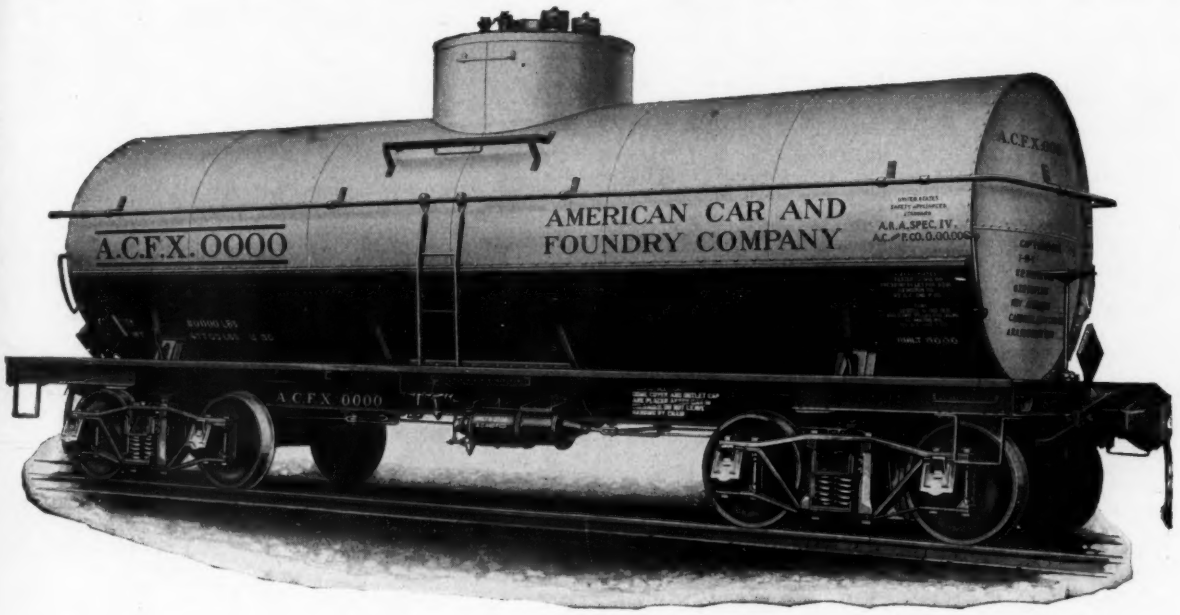


Figure 6—Alta Loma air lift pump station.



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per unit of vertical section of the sand, any larger diameter of well than necessary to recover this amount is an unnecessary expense, both in first cost and in maintenance.

The problem is different in oil wells though; the quantity of fluid in a sand is definite; there is no replenishment; the recovery of oil during flush production depends upon the free flowing capacity, and ultimate recovery depends upon the free flowing qualities of the oil through the sand to the well and into the well bore, so that the largest commercially obtainable diameters of wells is beneficial and commercially profitable in the production of oil.

The method of pumping wells depends largely upon the conditions as found. Figure No. 5 shows a line of shallow wells, twenty feet deep on an average, in which a suction line is used. Each well has a suction pipe from the main suction line and each branch pipe has a gate valve. The main suction line has a gradient upward to the pumps so that there are no air pockets. Any small quantities of air that may enter are immediately driven to and through the pumps. This suction line is 1600 feet long and although it seems to be rather long, it worked continuously, twenty-four hours daily for years.

For deeper wells, a line is shown in Figure No. 6 taken from the Alta Loma Air Lift Pumping Station. Air is compressed at the station in the center and distributed to each well by an air main with a branch pipe to each well. The water in this case is collected by gravity mains beginning at each outside well and terminating in a reservoir at the pumping station. Here the water is picked up by pumps and delivered 18 miles through a thirty inch main to Galveston.

Compressed air pumping for wells of depth or for wells making sand has the advantage that there are no working parts in the well and that air will handle sand continually. The disadvantage is in cost of operating, although with economical prime movers, such as gas engines or oil engines, driving the compressor, air compares favorably with smaller reciprocating units for each well. Attendance with air lifts is also lower than with any other system except that of suction directly upon the well.

It will be noted that no large open wells are included as a part of a system. Open wells are difficult to maintain, and because they draw upon but a short distance across a line of flow, many wells are advantageous rather than a single large well.

And wells with large capacity pumps are also omitted for the same reason. Although wells may have large capacity initially, constant withdrawal of water in large amounts from a given sand at a single locality will inevitably lower the static head of that well and increase the pumping costs and eventually require additional wells anyway. When water is withdrawn in large quantities intermittently, as is done for irrigation purposes, the sand has an opportunity for replenishment while the well is shut down, but heavy every day withdrawals all during the year for years results in higher water costs. Rather drill several wells immediately and draw upon them for the supply to prevent rising water costs and troubles of other kinds.

The cost of supplies of water from wells is always less than from reservoirs, both in initial investment costs and in operating costs. Lands must be purchased for the reservoir site, dam and spillway with head gates must be constructed, to impound water ready for the pumps; for a well system, a strip of land across the line of flow is all that is necessary, which may be from one to ten acres, and wells drilled thereon with pumping facilities. With shallow wells as shown in Figure No. 5, the cost per well was about $90.00 which was for a completed well, ready to connect up. This system of wells furnished water during a four year drouth when all available reservoirs failed.

Comparing reservoirs further, with wells: the areas underlaid by water bearing sands are usually more widespread in area as compared with reservoirs and the water content is therefore greater when a whole area is considered. Per unit of area, many wells systems show a greater water content than the largest reservoir system that could be constructed. But the main factor in making such comparison is the fact that when water percolates into a sand below the surface, evaporation is limited to a very small fraction of that on the surface while the writer has measured evaporation from the surface of reservoirs that reduced the visible supply equally as much every day as daily pumpage reduced it.

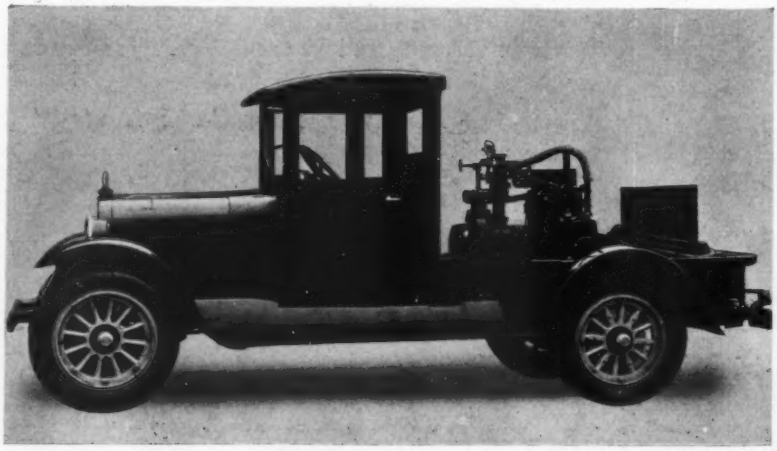
To develop any supply of water, there should be in sight at least enough water to supply the demand for two years without replenishment; many large reservoirs are built on the basis of four years for safety. In developing supplies of ground water supplies as outlined herein, we not only have the flow of water underground as a continual replenishment, but also the reservoir capacity of the sand as reserve supplies. And, when the slow rate of subsurface flow is considered in the sands usually developed, it may be seen that several years can elapse without replenishment before the sand could be exhausted, ond on this basis, supplies of well water are safer investment when development is done on a rational basis.

Empire Designs New Car For Field Testing

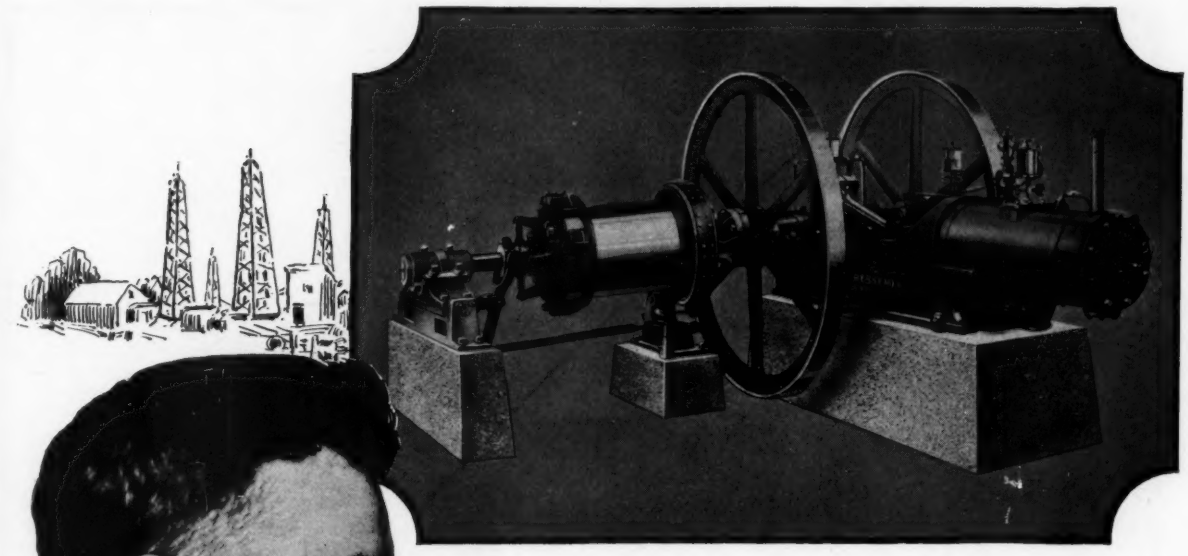
A new test car that is being used in the Oklahoma and Kansas fields as a settlement test and scouting unit has been equipped by the Empire Gasoline Company of Bartlesville, Okla.

The test equipment consists of a small vacuum pump with compressor, meter, condenser and accumlator mounted on a standard one-ton Graham Brothers chassis and the compressor and vacuum pump are propelled by a power take-off furnished by the truck manufacturers. This take-off is a part of the transmission of the truck and enables the operator to use the power of the engine while the transmission is in neutral position.

The unit is a miniature gasoline compression plant and duplicates on a small scale the field operations of this kind of plant. There are other units in the Mid-Continent performing this kind of service, but are not common on a truck of this size.



New Empire Test Car



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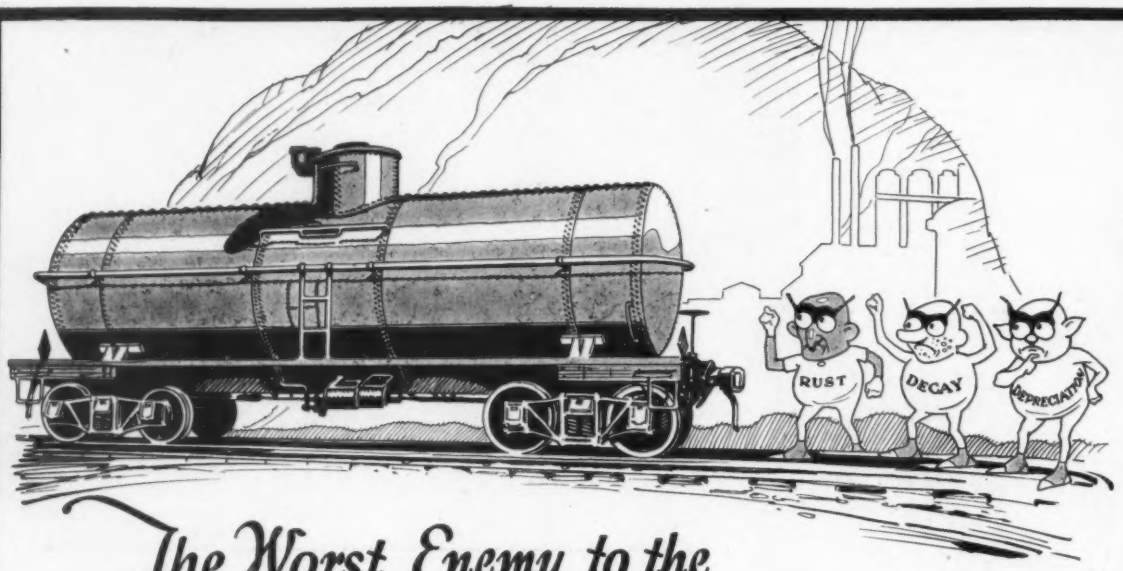

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Getting Electricity as a By-Product

The power salesman learns something that the refiner should know more about

By Gwynne Raymond

THE representatives of a large power project being developed among the towns of southeastern Kansas called upon the superintendent of an enterprising oil refinery in their territory.

"We are building a modern super power station at the coal mines near here," said the representatives. "Our high tension lines are going right by your refinery. We want to offer you the opportunity to secure unlimited power from us at the very attractive rates which are made possible by large scale generation at the source of cheap fuel. Continuous service will be assured you by two separate storm-proof transmission lines into your town. We are satisfied that we can serve you better and at a lower rate than you can secure in any other way."

"That is interesting," replied the superintendent. "How much will your current cost us?"

"In good sized quantities, say of 500 kilowatts per hour and over, continuous load, we can offer you the basc rate of a cent and a half per kilowatt." And the representatives leaned back to enjoy the effects of this generous offer.

"I am sorry, but that figure does not appeal to us at all," replied the superintendent. "We are generating our own power for less than a cent per kilowatt."

"Why, that is impossible!" objected the representatives incredulously. "You with your comparatively small plant cannot possibly generate electricity so cheaply as we can with our large stoker-fired boilers and enormous turbines, and our costs are well over a cent! There must be something left out of your figures!"

"No," said the superintendent. "Our figures are correct, and I'll tell you where the difference comes in. Power is the only product you sell, and you must of course make all of your expenses for fuel, labor, depreciation, etc., out of the sale of your power. To us power is only a by-product. We generate great quantities of steam for use throughout our refinery, in our stills, for heating our tanks, in our lubricating and paraffin departments, and so forth; and we simply pass some of this steam through our power turbines on its way toward the plant. Thereby we squeeze much of the power out of it and still have nearly all the heat available for plant use. Our power costs only about 8 per cent of the cost of steam going through the turbines, plus some labor and depreciation. Why, we could probably turn around and sell you our excess power cheaper than you can generate it, we have so much steam available!"

The refinery to which this true story relates generates about 4450 boiler horsepower of steam per hour, at a pressure of 150 pounds and 100 degrees superheat. The cost of generating this steam, including fuel, labor, water purification, and repairs is about $.2317 per thousand pounds of steam, or about $.008 per boiler horsepower.

Only about one-sixth,—730 H. P.—of this steam is passed through the turbines to generate all the electricity required to run and light the refinery. The remaining 3720 horsepower is delivered in high pressure steam lines over the plant to run pumps, for fire protection, and for miscellaneous process work.

The 730 boiler horsepower of steam, after driving the turbines, is delivered at 15 pounds pressure into low pressure steam lines which parallel the high pressure lines to the still batteries and other parts of the plant. These supply low pressure steam for distillation, heating tanks, and so on. The exhausts from all steam pumps, blower engines, etc., are connected into these low pressure headers so that no steam is allowed to escape and all possible is made to do double duty, that is, to furnish both heat and power.

In passing through the turbines the steam loses surprisingly little of its heating value,—only about 8 per cent. So it is fair to charge the power plant with only 8 per cent of the cost of its steam. This figure is so remarkably low that it probably needs a little explanation. Herein lies much of the reason why any plant which has to use steam for process or heating work can get power out of it as a by-product at a surprisingly low cost and still have practically all the heat left.

From steam tables we learn that the amount of heat contained in the steam as it enters the turbines at 150 pounds and 100 degrees superheat is 1250.5 B. T.U. per pound. And the amount of heat contained in the steam as it leaves the turbines at 15 pounds, no superheat, is 1165.7 B.T.U. per pound. So the difference has to equal the amount absorbed in the turbine. This is 84.8 B.T.U. per pound.

Now, all the heat contained in the original steam is, unfortunately, not available for use in the plant. Some is lost from the lines and some remains in the water after the steam is condensed and is lost in the condensate. It is safe to say that a maximum of 1172 B.T.U. out of the original 1250.5 may be used. Of this, the 84.8 B.T.U. consumed by the turbine represents 8 per cent.

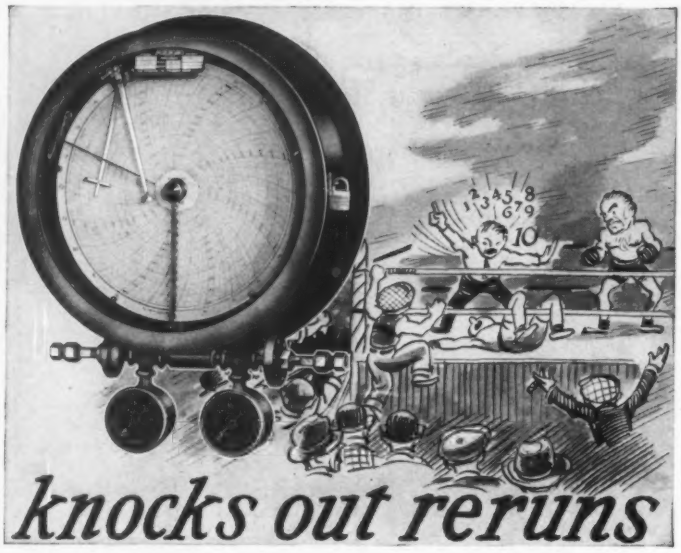
Now this is all quite technical, and perhaps not very satisfying. As good an explantion as any is to state that it takes an enormous quantity of heat to boil water, and only a very much smaller amount thereafter to raise the pressure of the steam formed. This second and much smaller quantity of heat, which raises the pressure, is all that can be turned into power, and the big amount consumed in boiling the water is available for heating purposes only, and remains available after the power is extracted.

The reader may have inferred that in this particular instance the use of turbines was part of the secret of getting the power out of the steam without wasting the heat. This is not the case. Steam engines of any kind would have done almost as well. Not entirely so well, however, for turbines get a little more efficient than engines as the sizes get larger, and turbines give you none of the troubles of cylinder oil in the low pressure lines.

These particular turbines generated an average of 600 kilowatts per hour, and required about 42 pounds of steam per kilowatt. Eight per cent of the cost of 42 pounds of steam is, per kilowatt, $.00083, and the cost of operating labor, repairs, etc., was $.00270, Total $.00353. Depreciation, and other fixed charges on the turbines and the power house, and a proper proportion of the boiler house, $.00392. Total, (at 10 per cent) $.00745.

Now if the power had not been generated, low pressure steam lines might not have been necessary, even though some plants not generating their own current have found them economical for collecting exhaust from pumps and engines and transferring it to heating buildings, feed water tanks, etc. In this case we will add an investment charge in the low pressure steam lines to the cost of power, just to play safe, $.00178, which brings the total cost of power up to $.00923, or less than one cent per kilowatt.

The refinery taken here for an example is a typical Mid-Continent complete refinery, running about 5500 barrels of crude per day to paraffin, lube oils and coke. The steam cost per barrel of crude run is about 18 cents,



Old Man Rerun is a pretty tough character. Refiners hate him. So a great majority of them install Foxboro Automatic Temperature Controllers on fractionating towers, knock-out boxes, primary condensers, auxiliary condensers, dephlegmator and bubble towers.

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including depreciation, etc. And the power cost is about 2½ cents per barrel.

The question of reliability is an important one when a refinery is deciding whther to make its own power. Much can be said on both sides of this argument. The transmission lines from the superpower station are just about as likely to fail as are the generators of a private plant.

I have in mind two refineries of much the same size and conditions. One of these is located in the outskirts of one of our very large cities. This one buys its power from the utility company which has power generating stations all over the countryside, all inter-connected with well constructed transmission lines. One would say that the power supply to this refinery is as well protected as it is possible to have it.

The other refinery is located in the oil fields, remote from power supply. This one generates its own power. It is, however, equipped with up-to-date water tube boilers, steam turbines and a first class power distributing system. The records of the failures of power of these two plants are surprisingly alike. Each has an average of three or four failures a year. Seldom indeed is a failure as long as two hours, and most are of but a few moments' duration. This comparison shows that from a standpoint of reliability a power generating plant within the refinery can show just as good a performance as can the best of central station service. In either case, of course, the price of steady performance is continued care and exaction on the part of the refinery management.

So with the reliability of a well built private power plant every bit as good as is the service from the central stations, and with the cost very much in favor of the private plant, every refinery which uses much steam for plant purposes should investigate the possibilities of generating its own power as a by-product.

Dodge Book Out

The Dodge Manufacturing Corporation, Mishawaka, Ind., has just released an elaborate book visualizing the engineering, foundry and machine shop facilities of that company available for the manufacture of special machinery and equipment. The book also shows a wide range of special equipment built by the company.

A copy of this book will be sent to executives of engineering and sales companies, as well as manufacturers who prefer not to build their own special machinery, but to use their plant equipment for the manufacture of their standard products.

F. E. Ninde has resigned as district manager for the Tulsa territory for the Ward Chemical Company

If you were prevented from employing men in your refinery under 32 and over 36 years of age, you would feel seriously handicapped

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60 to 70
60 to 80
70 to 90
80 to 90
80 to 100

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GREENE BROTHERS

Wichita Falls, Texas.

RECENT REFINERY PATENTS

BY STAFF REPRESENTATIVE

Washington, D. C.—The following patents of interest to the refining industry were issued by the United States Patent Office during May:

No. 1,536,831, granted May 5 to Gustav A. Ekstedt and Nicholas Schmueser, De Beque, Colo., for a shale oil eduction retort comprising an elongated retort chamber having a substantially rectangular cross-section, transverse supporting bars within said retort, a shelf supported from each end of said bars, said shelves forming vertical tiers, roller bearings between the supporting bars and the bottom of the shelves, a vertical shaft rotatably mounted near one end of said retort, a cam secured to the shaft and adapted to positively operate two adjacent layers of shelves, said cam having means cooperating with intermediate connecting means for moving the shelves alternately, slowly and then quickly in opposite directions.

No. 1,537,164, granted May 12 to William L. Gomory, Chicago, assignor to Clifford M. Leonard, Chcago, for a continuous process for cracking hydrocarbons which consists in mixing steam with the oil to be cracked, continuously forcing the mixture under a pressure about 150 pounds through a conduit heated to approximately 1000° F., the temperature and pressure being such as to permit about 15 to 20 per cent of the hydrocarbons to remain in the liquid phase, passing all the products from said conduit to an enlarged space not directly heated and permitting the heavier, unvaporized hydrocarbons to separate therein without raising their temperature, separately condensing the less volatile and more volatile hydrocarbons and returning the former to the heating conduit.

No. 1,537,189, granted May 12 to Otta A. Peters, Wichita Falls, Texas, for an oil flow tank having a housing mounted on said tank, a plurality of tubular members attached to said housing exteriorly of said tank, a tubular member attached to the bottom of said housing and extending downwardly in said tank, and a second tubular member attached to the first mentioned tubular member near the upper end thereof to provide for release of gas pressure.

No. 1,537,593, granted May 12 to Gustav Egloff, Independence, Kans., assignor to Universal Oil Products Co., Chicago, for a process for cracking oil, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs, in subjecting the vapors to reflux condensation to condense the heavier vapors, in passing the reflux condensate in an advancing stream through a heating zone where it is subjected to cracking conditions of temperature and pressure, in delivering the heated condensate to said enlarged zone and simultaneously heating an independent stream of charging oil for delivery to said enlarged zone to a temperature sufficient to cause a substantial vaporization thereof in said zone, and in introducing said heated charging oil to the enlarged zone.

No. 1,538,150, granted May 19 to Edward Wilson, St. Louis, assignor to Wilson Engineering Co., St. Louis, for an oil separator, comprising a filtering chamber, a compressed fibrous filter in the filtering chamber, a baffle device extending into the filtering chamber, an oil reservoir below the filtering chamber, a pipe extending some distance into the oil reservoir, and means within the oil reservoir preventing oil from entering said pipe.

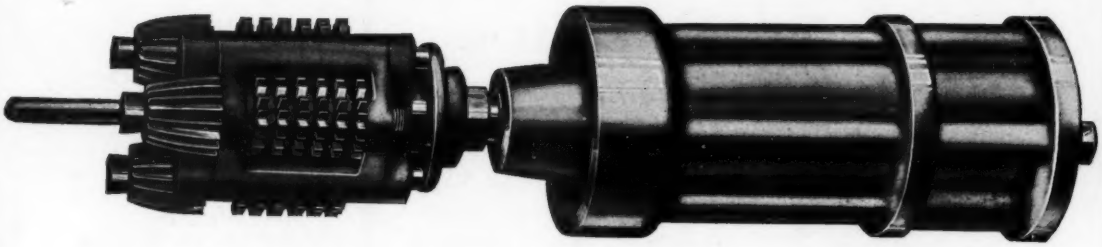
No. 1,538,287, granted May 19 to Wolf Kritchevsky and Harold C. Prutsman, Chicago, assignors to William Citron, trustee, Chicago, for a method of deodorizing kerosene which consists in treating the same with chlorsulphonic acid, then washing, then treating with an alkali, and then treating with a solid absorbent colloid.

No. 1,538,739, granted May 19 to Henry Frederic Owen, Maricopa, Calif., for a process of dehydrating oil which consists in continuously passing oil through a heater in a stream, characterized by confining said stream in a conduit, whirling said oil in said stream, transmitting heat to said stream, and separating the water from the oil.

No. 1,538,954, granted May 26 to Hans Rosenthal, Berlin, Germany, assignor to Julius Pintsch, Aktiengesellschaft, Berlin, Germany, for a method of distilling oil shale and similar bituminous fuels by means of internal heating, consisting in wholly or partly burning in a special pre-heater the gas resulting from the gasification of the shale residue, said gas giving off in the pre-heater the heat resulting from its combustion on to a gas, which continuously circulates through the fuel and acts as a heat transmission means.

No. 1,539,647, granted May 26 to Donald Ernest Chase, London, Eng., assignor to Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij, The Hague, Netherlands, for a process of separating petroleum emulsions by applying the electrical energy to the liquid in the form of a high frequency alternating current.

Deposits In Cracking Still Tubes Must Be Removed



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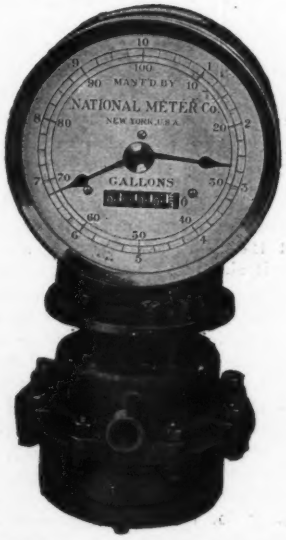

For the various operations of refining, compounding, or marketing, where accurate measurement is essential, EMPIRE Oscillating Piston Oil Meters will be found always efficient and dependable.

The design of these meters, which is quite different from that of any other type, gives the EMPIRE a **lasting** accuracy not to be found in any other meter offered for oil-measuring work.

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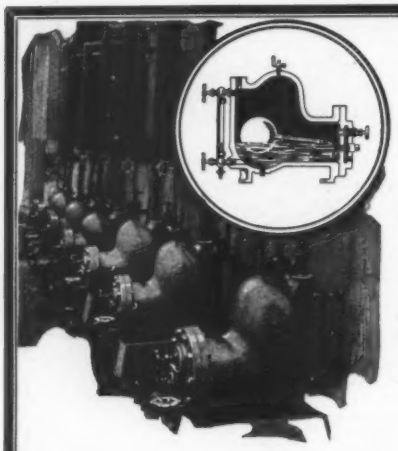

Trap Your Gasoline

Illustration shows American Ideal Traps in the Absorption Tower of the natural gasoline plant of Palmer Corporation, Schwartz, La. These traps are used to trap gasoline from the absorber and to catch the residue gas passing back to absorber, where it is again picked up by the mineral seal spray and the gasoline absorbed by same.

AMERICAN IDEAL STEAM TRAP

has an unusually large valve opening, consequently you can use a smaller, therefore a less expensive American Ideal Trap and handle the same volume.

This extra large valve orifice makes it impossible for the valve to clog or chatter. Seat can be removed without making disconnections.

Is equipped with an extra heavy seamless copper float of exceptionally large diameter, which is guaranteed for the life of the trap.

Other features explained in our interesting booklet. Write for Booklet S-16.

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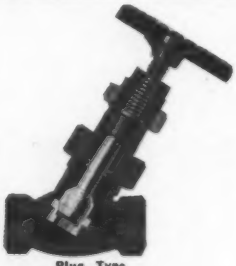

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Fire Brick

Maintenance Engineering Corporation

1802 Conti Street -:- Preston 5580
HOUSTON, TEXAS

Magnolia Accomplishes Real Conservation

(Continued from page 17)

the oil industry are in use in the Magnolia plants. The company has built some burners in its own shops.

Still Experimenting

It is the intention of officials of the company to continue tests of burners until the combination most economical for the burning of gas is found and then to adopt it for the refinery.

One method that proved good for burning gas was to use steam for an aid in creating a draft along with the consumption of the gas. This use of steam, however, involves an expense that it is desired not to assume.

While the Magnolia is using natural gas for refinery fuel, all the oil burning equipment is still in place. It remains for emergency use. Within 10 minutes, the fires under stills and boilers could be shifted back to oil. Fuel oil tanks are kept full, the pumps in working order and the burners ready.

In changing from oil to gas as a fuel, the work was carried out so no time loss could be charged solely to this work. This was accomplished by installing gas burners when stills or boilers were shut down for other purposes. At the regular times for cleaning out stills, workmen were put to installing the gas burners. Similar arrangements were used in the placing of gas burners under the boilers.

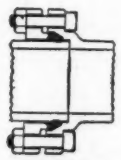
Furnace Changes

Aside from installing gas burner equipment, the only other changes made in equipment consisted of providing larger furnace area under the stills. This was accomplished by removing the grate bars that separated the furnace proper from the ash pit. Since burning gas leaves no ash, removal of this flooring accomplished the provision of greater furnace area and at the same time leaving the furnace as it should be for gas consumption.

Proper pressure, proper drafting and adequate furnace area are the matters still under experiment at the Magnolia plants. Those in charge of operations are seeking the most economical use of gas fuel, when the natural draft of the stacks is drawing against the fires.

At the La-Tex pump station near DeBerry, Texas, the Magnolia Gas Company has built a natural gasoline plant for extracting gasoline from the gas that passes through the main on its way from Louisiana to the Beaumont refineries. The gas is "lean" but sufficient gasoline can be recovered to warrant erection of the plant. It also serves to condition the gas for burning before it reaches its destination.

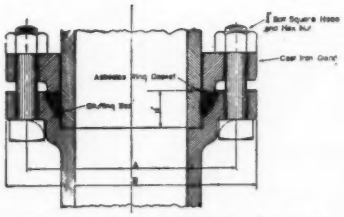
SIMPLEX CAST IRON CONDENSER PIPING



"ONE FLANGE IS LOOSE"

Settles the Rust Question

Progressive refineries now secure the durability of cast iron pipe in their con denser coils without the disadvantage of standard flanged pipe construction. Our Simplex joint, using a triangular shaped, endless asbestos gasket, is the secret. It is fully described and illustrated in our Catalog No. 55. Your copy is ready to be mailed upon receipt of your request.



Cross Section Assembled Simplex Joint

Do you know why cast iron resists corrosion so much more than other ferrous metals? Our Bulletin No. 44 explains it.

Write for Simplex Condenser Catalog Number 55

AMERICAN CAST IRON PIPE COMPANY

General Offices and Foundry: Birmingham, Ala.

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This Precision Thermometer is calibrated for four inch immersion and is manufactured with the greatest care to insure accuracy. This thermometer is adopted as the standard by the American Society of Testing Materials, the American Petroleum Institute and the Inter-Departmental Petroleum Specification Committee of the Government.

Tycos Temperature Control in the refinery.

Tycos Temperature controls are used on closed feed water-heaters, superheated steam lines, condensers, cooling coils, hot water tanks, oil pre-heaters, steam stills, knock out boxes, etc. This is done by installing either Tycos Singl-Duty, Tycos Dubl-Duty, Tycos Type-P or Tycos Electric-Contact Controls.

Write for Catalog of Tycos Instruments used in the Production and Refining of Mineral Oils. Ask for Catalog Part 1700.

Taylor Instrument Companies
Rochester, N. Y., U. S. A.
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There is a Tycos or Taylor Temperature Instrument for Every Purpose.

Extracts From Refinery Technology

Hydrogenation of Paraffin Wax.—The hydrogenation of oils, fats, waxes, etc., is a technical process which has assumed considerable importance in various industries. Thus for example it might be mentioned that a great solvent industry has been established in Germany in which phenol and naphthalene are hydrogenated, made to combine with hydrogen, to yield the important solvents hexalin, tetralin and decalin. The application of this process to the petroleum industry is therefore of considerable interest.

Experiments were carried out with paraffin wax which had a melting point of 59 degrees C. About 200 grams of the wax were heated in an autoclave with agitation. Steel balls are introduced, without the use of hydrogen and in the presence of hydrogen at a high pressure.

It was found that the hydrogen enters into combination with the wax and results in the production of less unsaturated distillates and a residue of lower density. Without hydrogen the formation of coke commences after two hours, but in the presence of hydrogen practically no coke is formed and the bromine values of the distillates and the residue are lower, a larger yield of gasoline and kerosene are obtained and less gas. The residue contained 85.4 per cent of carbon and 13.8 per cent of hydrogen, as against 918 per cent and 8.2 per cent in the simple cracking process.—Jour. Inst. Pet. Tech., 1925, 11, 36-60.

* * *

Water Soluble Tar Oils:—Tar oils may be treated with a concentrated aqueous solution of an alkali salt of a sulphonated vegetable oil in order to obtain an emulsion of the tar oil which is soluble in water. For example 30 parts of tar oil are emulsified with one part of 40 degrees Be. caustic soda solution, six parts of turkey red oil and one part of soap lubricant. Swiss Patent No. 106,549.

* * *

Continuous Distillation of Petroleum:—Present day continuous straight through systems consist in passing the petroleum or other liquid successively through a series of stills of equal dimensions, the liquid passing into the unit at the first still and the residue passing out from the last of the unit. The distillates from each still are condensed in suitable condensers.

According to an address delivered to the Institute of Chemical Engineers in England, a mistake is made by making all stills, condensers and auxiliary apparatus of the same dimensions, for although it may be intended to take the distillate off in equal fractions, to do so means that the rate of distillation must be eased off successively to allow for the reduction in volume passing successively from one still to another throughout the series. A detailed example of what is meant by this sort of operation is given in the original, which is found in the May 2 issue of the Chemical Age of London.

From a study of the conditions as outlined in the article it is concluded that the stills must be of different dimensions and likewise the condenser tanks. The condensers may be of any type, but must be so designed that the following features are developed:

1. Each condenser must necessarily be of diminishing size, as each successive still yields a diminishing volume of the distillate.

2. The boiling point of the distillates throughout the series will increase with the passage of the fluid through the unit.

3. The lighter distillates are of the lowest boiling point and therefore possess greater volatility and require a considerable excess of water to cool them in order to avoid loss, and these distillates are obtained at the first still.

4. Therefore by suitable adjustment of the inlets and outlets of the condensing water, the whole of the water required for the perfect condensation of the distillates from the whole unit can be made to pass into the condenser for the first still and then into the condenser for the second still and so on through the series.

This means that the consumption of water is at a minimum and much fuel is saved in useless pumping of an unnecessary volume of water.

* * *

Motor Fuel with Iron Carbonyl:—The use of various substances which have a catlytic action on the combustion of the fuel in the internal combustion engine has been attracting a great deal of attention in the past few months both from a technical and other standpoints. A new development which has been brought out in Germany and which is described in British Patent No. 226,731 refers to the use of iron carbonyl as an "anti-knock" agent in liquid fuels. For example this substance is dissolved in alcohol, gasoline or other hydrocarbon to the proportion of 0.1 to 1 per cent. It is possible to make the carbonyl directly an simultaneously with the manufacture of the fuel, the carbonyl being formed by the passage of carbon monoxide gas over finely divided iron fillings.

* * *

A New Motor Fuel.—During the past few years French technologists have been supported by their government in the search of a fuel that will

(Continued on page 61)

The Dependable Temperature Measure

Brown Duplex Continuous Recording Electric Pyrometer

Simple as a clock—Accurate—and always on the job.

No wonder that refinery men everywhere—the men responsible for big gasoline yields, put their trust in Brown Electric Pyrometers. Brown's have earned their confidence by constant, faithful service, day in and day out, on every kind of application. And remember, when it is necessary Brown Electric Pyrometers can be adjusted, wiring can be repaired, or a thermocouple changed, quickly—right on the spot.

Why not make use of our years of experience in serving the Oil Field? We invite your inquiries on all matters touching temperature control.

Address—The Brown Instrument Company, 4535 Wayne Avenue, Philadelphia, Pa., or one of our district offices in New York, Boston, Pittsburgh, Detroit, Chicago, Birmingham, Houston, Tulsa, Denver, Salt Lake City, San Francisco, Los Angeles or Montreal.

Brown Pyrometers
Most used in the world

Why METALLO-Made Pipe Joints

Metallo Copper-Asbestos Gasket

Metallo Valve Discs

have a core or filler of compressed asbestos entirely enclosed with high grade copper, forming an elastic and resilient cushion on which the valve seats will close tightly without injury to either disc or seats. Metallo valve discs can be used successfully on high pressure steam, hot or cold water, gas, air, etc., and one of them will outlast at least six ordinary valve discs. They are made with either round or square holes, for use in Jenkins, Globe, Angle, Cross, Blow-off, Radiator or similar valves. Round hole discs come in ¼, ⅜ and ½-inch, and all sizes above 2 inches. Square hole in ¾ 1, 1¼, 1½ and 2-inch.

Stay Tight

PIPE JOINTS that are made with Metallo Copper-Asbestos Gaskets stay tight because, when the flange bolts are tightened, the copper corrugations and the asbestos cord that lies between them are set firmly against the flange face on each side, creating alternate walls of copper and asbestos through which neither steam nor water can pass, even at the high temperatures and pressures of present-day practice. And Metallo Gaskets do not require constant "following up" to KEEP them tight.

This superior gasket service is given almost unbelievable permanence because Metallo Gaskets combine the all-enduring qualities—the lasting resilience—of 14-ounce copper with the heat-resisting powers of the best of asbestos.

In fact, Metallo Copper-Asbestos Gaskets have so much "come-backability" that they are used over and over with perfectly satisfactory results.

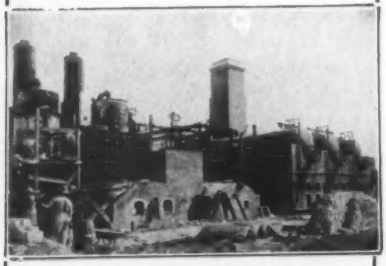
Will you try them for 90 days at our risk and do yourself a real favor?

METALLO GASKET COMPANY

242 Lafayette Street, NEW YORK CITY
Factory at New Brunswick, N. J.

An Authority on Oil Still Construction Says:—

"High temperature cement has to a great extent taken the place of fire clay in recent years, especially where extremely high temperatures are required. This cement is applied between the brick in the form of a paste and a thin layer is spread over the face of the brick. After the furnace has been fired, this cement unites the brick into a solid wall, and forms a glazed surface over the brick, thereby protecting the brick from disintegrating under the extreme heat."



Many Oil Producing and Refining Companies are using

HYTEMPITE

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because HYTEMPITE bonds at normal room temperatures and the bond extends through the entire thickness of wall or arch.

400 pounds will lay 1000 brick

HYTEMPITE is warehoused at or near all oil fields and industrial centers for immediate delivery.

Instruction booklet HO-109 on request.

QUIGLEY

Furnace Specialties Co.,

INCORPORATED

26 Cortlandt St. New York

Safe Practice in Gasoline Manufacturing

By C. L. Swim

Skelly Oil Company

NO machinery is dangerous except in the sense that it is easy for the employe to come in contact with it, by slipping, falling or being brought into it by auxiliary or adjacent machinery. Safe habits and practices cannot successfully be crammed down employes' throats but must be sold to them.

Get Them Easily

The new employe who has passed a satisfactory medical examination is in his most receptive mood for safety ideas. He is anxious to make good, and if at this time his foreman explains his duties and how to perform them safely, and that safe practices are a cardinal principle at that plant, there has been very effective work performed. New men sustain injuries all out of proportion as compared to those who have been employed for longer periods. The key men are your superintendents and foremen. Your program of accident prevention can most effectively be carried to the men by having meetings called by the superintendent or foreman in which these matters are discussed, unsafe practices pointed out, and safe practices emphasized. Fully as important are bulletins persistently and from various angles presenting the safety idea. Much good may be accomplished by giving particular attention to the individual who sustains frequent injuries.

The operators of the Mid-Continent fields have established a safety council, carrying on its prevention work by motion pictures and bulletins. The advantage of approaching this question as an industry, as an additional effort to that of the individual operators is, that the men of the industry are reached by the motion pictures whereever there are 50 or more men, although there are only a few employed by any company. Much of our work can be done through this council more cheaply with the added advantage that new men have had some training in safety. The work of this council is foundation work only and to get real results you must have a program of your own thoughtfully and persistently carried out.

Fire Prevention

Fire prevention can well be made a part of your program. In your business explosions are in many cases the cause of the fire or coincident with it. Legislative bodies cannot be as familiar with the problems involved in manufacturing and transporting gasoline safely as you who are in daily contact with these problems, and yet do you think the Ardmore disaster of a few years ago could be repeated many times without there being an atempt made to regulate the transportation of gasoline by legislative enactment. You who make gasoline know that gasoline is safe when safely handled, but this very knowledge on your part lays upon you the obligation to set for yourselves such standards, and to so train your employes that the minimum of accidents may occur.

The effect of better guarded machinery, the installation of various safety devices, the use of equipment designed in accordance with definite safety standards, better plant layout, better housekeeping, better venilation, better lighting, better all around working conditions, a better morale and increased loyalty on the part of employes, not only reduce accidents, but increase operating efficiency and often actually decrease operating costs.

It matters not how much gasoline you make unless you make it at a profit. The business concern that makes a notable success is the one that has eliminated waste. The waste of effort and of money from unsafe practices is the least defensible for by no method of

BURRELL

Write for Our New Catalog of

OIL TESTING APPARATUS

32 pages of up-to-the-minute equipment including:

All A. S. T. M. Instruments
Thermometers
Hydrometers
Distilling Outfits
Gas Analysis Apparatus
Manometers
Vapor Pressure Bomb
Gas Tester for gasoline content.

ETC., ETC.

Specify Catalog "J"

Burrell Technical Supply Co.

Pittsburgh, Pa.

Why not have your own copy ?

The man who is either managing or working for a refinery or gasoline plant has every reason to read a business paper telling what is going on in that industry.

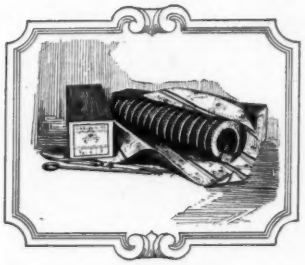
During the past year The Refiner and Natural Gasoline Manufacturer has printed more than 50 articles of a technical nature of direct interest to refiners and natural gasoline plant people.

If you are reading a copy subscribed to by your company, or a sample copy, why not send in a dollar today and have the Refiner and Natural Gasoline Manufacturer sent to your home, where you can keep a file?

The cost is $1 per year

GARLOCK

Quality Controlled



QUALITY CONTROLLED GARLOCK PACKINGS are manufactured in our own factories "from the Crude to your Satisfaction." All raw materials are tested in our laboratories and have to meet GARLOCK standards before acceptance. The building of GARLOCK products is the work of trained craftsmen. Each article is thoroughly inspected before shipment.

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PALMYRA, N.Y.

Sales Offices in all Principal Industrial Centers

The Standard Packing of the World

Tell them where you saw the ad.

bookkeeping can it be made to show an offsetting return. Accident prevention in the oil industry is no longer looked upon as welfare work, but is considered an important factor in production. One of the largest oil companies reports that its three years of accident prevention work ending December 31, 1923, resulted in a reduction of 50 per cent in the frequency of accidents causing a loss of time and a reduction of 52 per cent in the total cost of accidents. One very large rubber company advises that two years after beginning accident prevention work its lost time accidents showed a reduction of 62.7 per cent and seven years after beginning the reduction was 86.3 per cent. The only concerns that do not believe in accident prevention efforts are those that have not tried it.

Accidents may be divided into two major classes, by machinery, through failure to properly safeguard it, and by the human element. These classifications each suggest their remedy, the first to guard properly such machinery and the second to sell employes the safety habit and see that they stay sold. Not to exceed 15 per cent of all injuries are caused by machinery while 85 per cent, or the great majority of accidents, are due to the human element, which shows the relative importance of selling safe habits to the employes. You may guard your machinery with all the devices and still your plant is no safer than the employes who work in it.

Suggested Program

Briefly the lines of approach for a comprehensive safety program are:

1. Physically fit and mentally alert workmen.
2. Such mechanical safeguards as are necessary to provide a safe place to work.
3. Educational and personal effort to inculcate safety habits with their attendant safe practices.

As a foundation for every safety program I would place medical examination to avoid getting those into your employ who by reason of accident or disease are a liability rather than an asset. In addition you will be able to place your men at such work as they are physically able to do and will avoid for example causing the death of a man who may be perfectly able to do most kinds of work but who would be overcome by working in a place of extreme temperature by reason of his heart action or high blood pressure. By medical examination you will find some suffering from a previous injury or disease, and more often the latter, the effect of which is that, in case they sustain a minor injury in your employ, there will develop complications not yielding to treatment, resulting in a long drawn out and very expensive case, which by the laws of most of the states you are required to pay for without having been responsible for more than the minor injury.

Because of 1925 Indications It Is Wise to

Make Leasing Arrangements Now

1925, according to all indications, is to be a big shipping year. That means big demands on rolling stock.

By making leasing arrangements now, you assure yourself of the facilities needed to take care of your requirements.

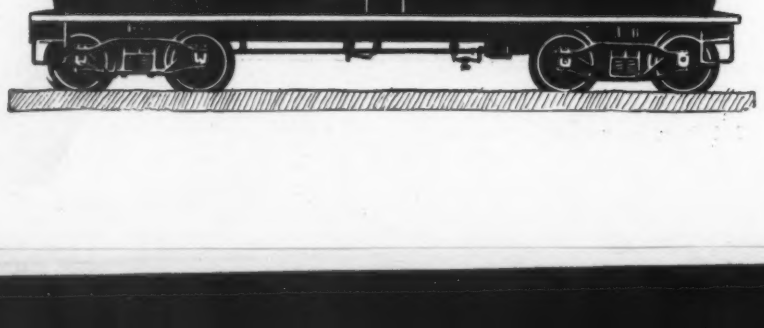
North American, as always, is at your service.

If you OWN cars, now is the time to get them in shape. Our 3 big repair shops are at your service.

NORTH AMERICAN CAR CO.

327 S. LaSalle St., Chicago, Ill.

Southwest District Office: Petroleum Bldg., Tulsa



American Chemical Society Meetings Are Announced

Pittsburgh, Penna.—The second annual meeting of the American Chemical Society will be held in August at Los Angeles, according to announcement from the office of George A. Burrell, secretary of the petroleum division of the society. The spring meeting will be held in April, 1926, at Tulsa. Petroleum subjects will make up a big share of each program.

There are always 20 or more papers and addresses which deal with various phases of petroleum technology. In addition there are subjects of general world interest and importance discussed, and many papers dealing with all various phases of chemical, biological and chemical engineering matters.

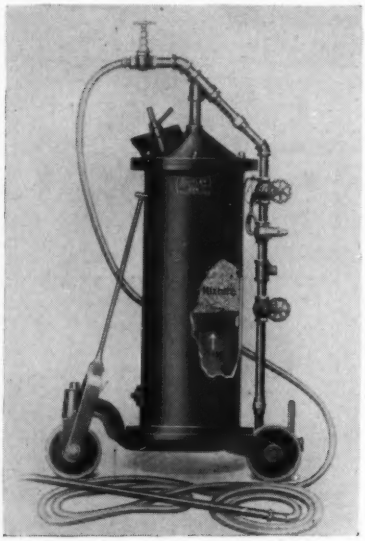
The American Chemical Society has the largest membership of any technical society in the world.

Refractories Bulletin

Refractories and furnace design make up the subject matter of a catalog published by the Plibrico Jointless Fire Brick Company, Chicago, Illinois. This catalog takes up the cause of furnace trouble and gives a solution, stressing the use of refractories manufactured by this company.

Copies of the catalog will be mailed to anyone interested.

NEW EQUIPMENT, CATALOGS, BULLETINS, BOOKS



Quigley Refractory Gun

Quigley Refractory Gun Operates Economically

Relining, patching or surfacing furnace walls with great speed and at low cost, is being accomplished by the use of the Quigley Refractory Gun.

Refractory materials of plastic consistency to conform with the best known refractory practice of today in the maintenance of boiler and furnace walls are applied with this gun, which is operated by compressed air.

A great saving in labor, time and material has been quickly recognized by furnace engineers and operators.

Success in the use of this gun is due to the fact that it will apply pre-mixed materials at a surprisingly low cost.

It also enables quick repairs or hot patching of furnace walls or baffles in places not easily reached by hand patching methods.

Pre-mixed refractory material is placed in the gun. The nozzle is then pointed at the place to be repaired, and the gun operator, by handling the valve controls, forces the mixture from the gun through a section of hose to the nozzle where the repair man makes the application.

Pressure required will vary from 90 to 100 pounds, depending on the nature of the material. For heavy plastic mixtures, pressure from 90 to 100 pounds is used, and for thin mixtures work has been done at pressure as low as 50 pounds.

As the illustration shows, the gun consists of a cast iron cylinder from which the material is forced by pressure applied to the piston. Pre-mixed plastic material is placed in the gun through a charging opening (A) in the top.

Pressure is applied at the bottom of a piston through pipe connection P, and controlled by valve B. As the piston rises, the mixture is forced into the Y connection C from which point it is carried through the hose to the nozzle by the combined pressure of the piston and pressure through the air control valve D.

A drain plug G is provided just above the piston and a quick opening cock for releasing the pressure under the piston at H. When the gun is emptied the cock H is opened, and the piston returns to its former position. The gun is then ready for refilling. It has pressure gauge and pop safety valve at J.

The gun has a capacity of two cubic feet of mixed material. It is mounted on three wheels, and can be easily moved from place to place around the plant.

The Quigley Gun when not required for furnace repair work can be used about the plant for rough white-washing, spraying paint or handling plastic mixtures such as stucco.

It is manufactured by Quigley Furnace Specialties Co., 26 Cortlandt Street, New York, and further information can be obtained from the company.

Two-Speed Winch Saves Work of One Man

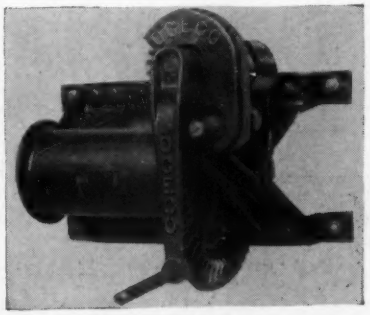
The Oil Conservation Engineering Company, Addison Road and New York Central Tracks, Cleveland, Ohio, is putting on the market a new type of tank winch. In addition to the regular safety features of all OCECO equipment, this winch made especially efficient by having two speeds.

In raising swing lines of 12 inches in diameter and over, in order for one man to handle it, it is necessary that a winch be geared to a very low speed. However, after the swing pipe is partly raised, the load becomes very much less, due to the difference in angle and a man could handle it at a much higher speed if the gear ratio would permit.

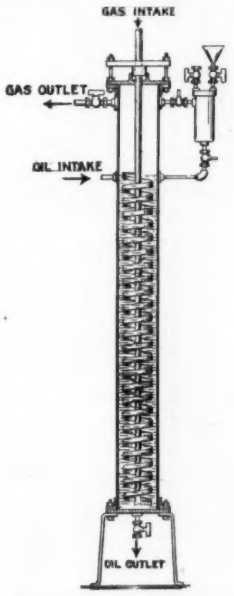
With the new OCECO winch it is only necessary to change the handle from one shaft to the other to obtain the higher speed ratio. In this way one man can raise the heaviest swing line and do it quickly and safely.

All bearings have graphite bronze bushings and the winch is of heavy duty construction throughout.

Further information will be supplied by the company upon request.



OCECO Two-speed winch



Flanged Spiral Absorber Allows Control of Factors

The absorption process for the extraction of gasoline from natural and casing head gas has established itself in commercial practice, and in the confidence of practical producers.

There are five factors to be considered in the absorption of gasoline by the oil.

1. The temperature of the oil and the gas.
2. The pressure of the gas.
3. The gasoline-absorbing constant of the oil used
4. The surface of contact between the gasoline and the absorbing oil.
5. The time of contact of the absorbing oil with the natural or casing head gas.

Fixed Factors

Of these five factors, the first three are fixed and determined by the conditions of working.

Thus the temperature is fixed by the

weather and field conditions, and by the working action of the exchangers.

The pressure is fixed by the field conditions.

The absorption factor is fixed as soon as the particular absorbing oil is put into the absorber.

These three factors of temperature, pressure and absorbing power of the oil are each and all worth noting; but they are apt to become fixed. But the other two factors, the surface-of-contact and the time-of-contact—these are under the control of the designer and builder, and they offer the very greatest opportunity for improvement in efficiency and economy.

The Flanged-Spiral Absorber has been designed to utilize the control of the surface and time control of the intimate mixing of the gas and absorbing oil.

Spiral Design

The basic idea of this absorber is a continuous spiral baffle plate—much like an enormous auger blade, with a side flange hanging from the outer edge of the spiral plate, as shown in the accompanying illustration.

The pitch of the spiral turn is so arranged that there is a strong rising current given the oil by the ascending gas; and the side-flange is so made that none of the gas can escape from under the lower side of this continuous spiral plate till the gas shall have risen to the top of the liquid oil.

This buoyant rising of the gas through the oil, and in a continuous centrifugal motion, gives both oil and gas an almost inconceivable whirling motion—which dashes the gas into fine spray and bubbles, which mix well with the oil.

All this, with the greatly increased path of travel of the oil and gas, round the spiral plate, greatly extends the distance of travel—to several hundred feet in a large absorber——and also extends the time from a few seconds as in the common absorber, to several minutes.

Also, the open space, between the lower edge of the side flange and upper surface of the next lower spiral, gives full chance for the oil to mix with itself, and with that portion under the spiral plate just above—so that there is always full and complete mixing of all of the oil.

Laboratory Test

When a small model of this absorber is sunk in a glass cylinder of oil one will notice that the bubbles of gas do not rise to the top of the liquid for some twenty seconds, while with an open tube the time is only about one or two seconds and even with common bricks and baffles the time is only a few seconds.

Also, one notes that the whirling bubbles fly up through the liquid much like a lead bullet at the end of a string, so violent is this centrfugal motion; and all happens with no moving parts in the absorber—due entirely to the spiral baffle, and the side flange for holding the gas under the lower side of the spiral plate.

This absorber can be adjusted to any standard oil absorption plant. It can be made of any width or height, and pitch of rise. It can be used either alone in one absorber or with a series to insure complete absorption.

The oil should not be filled above about three-fourths of the height of the absorbing tank, as the motion makes some foam, and also it takes the gas longer to pass up through the depth of the absorbing oil, but these are mere details of local calculation and adjustment.

The economy of this absorber is high; the cost is low; the efficiency is as good as the best—the charcoal or other more expensive absorbing plants. The one great advantage of this absorber is that perfect mixing, with large surface of contact and long time of contact, is obtained, and with no moving parts of the apparatus.

Jenkins Unit Ordered

Arkansas City, Kan.—The Kanotex Refining Co fo this city has contracted with the Graver Corporation of East Chicago, Indiana, for a thousand barrel Standard Unit of the Jenkins cracking process. Installation will follow immediately to take care of present requirements at the plant.

The Collins Field Type Boiler

The "Collins" Field Type Boiler will make dry steam moderately super-heated with a steady water column; operating with greater fuel economy at any rating than other field type boilers; and is guaranteed to carry 200 per cent of its rating continuously without injury. It will produce full head steam from cold water in less than 30 minutes, without injury. These boilers have many improved features, such as immediate response, great flexibility, rapid and complete circulation, accessibility to tubes from outside, large water capacity and extra rugged construction for hard service. The 80 H.P. size is portable and can be placed in operation within a few hours after delivery. Equipped for oil and gas fuel and admirably suited to oil field service.

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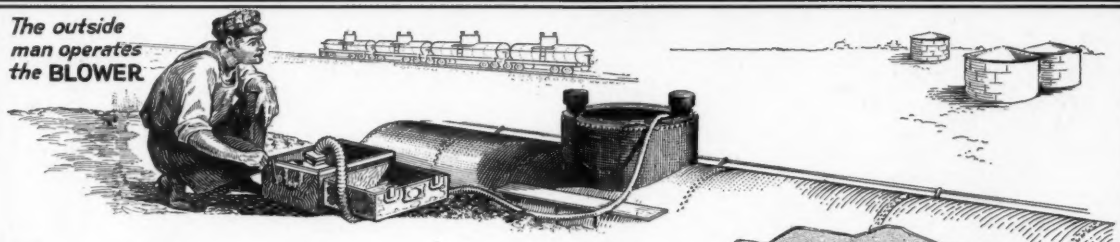

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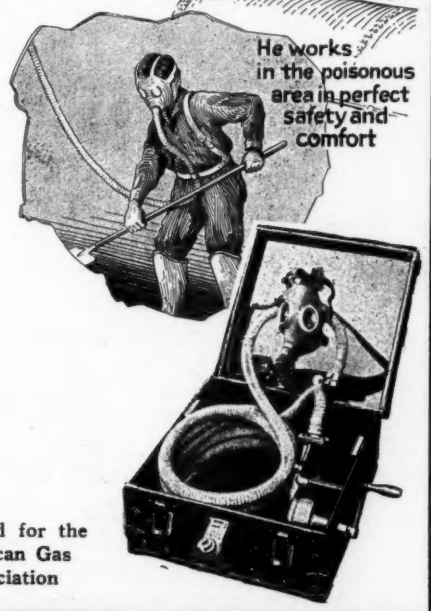

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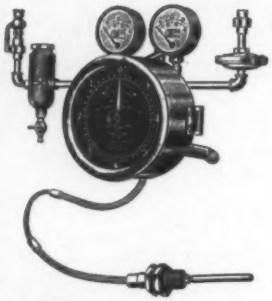

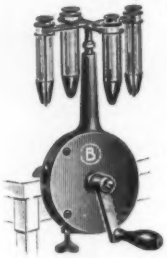

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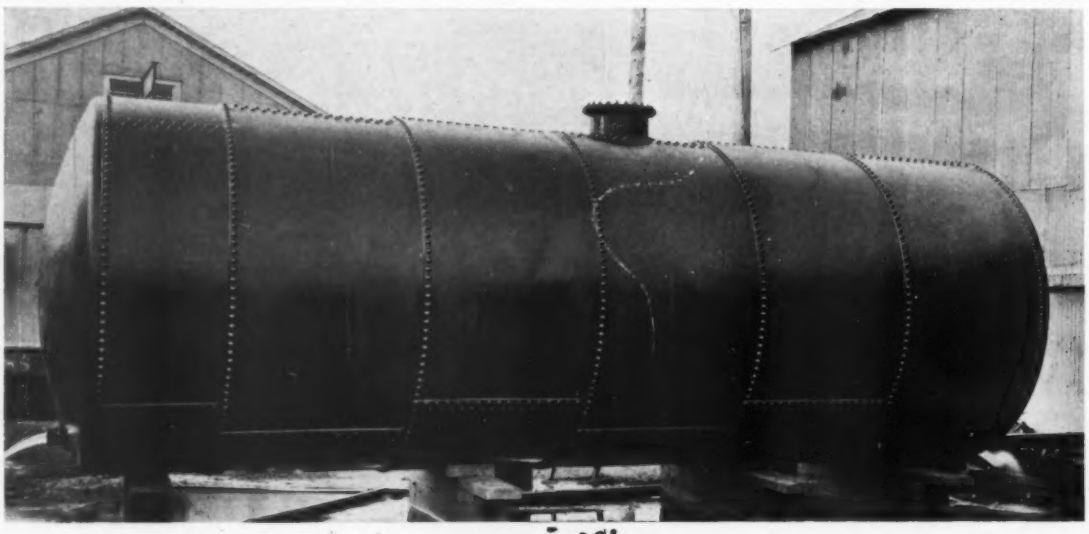

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Texas Natural Gasoline Output Is Declining

Fort Worth, Texas. — Natural gasoline shipments from plants in North and Central West Texas during the first four months of this year averaged 16,141,440 gallons per month as compared to a monthly average of 17,778,348 gallons during the corresponding period in 1924, thereby indicating the passing of the peak production of this product in Texas until new "wet" gas fields are uncovered. Natural gasoline manufacturers are now utilizing nearly all the desirable gas available for plant operation in Texas fields, and the limited volume of field work carried on in Eastland, Stephens and adjoining counties during the past two years has not furnished sufficient gas to offset the natural decline of old wells. Plant owners are continually seeking new gas contracts to augment their supply, and are closely observing wildcat drilling in prospective "wet" gas areas to locate new plants in the event an ample supply of gas is made available.

Eastland and Stephens Counties, which are the major sources of natural gasoline in Texas, are now experiencing a gradual increase in drilling activity in the old fields as well as undeveloped areas, and considerable new gas production is anticipated from these two counties before the close of summer. The Barney Carter field in the southeastern part of Stephens County is to receive its first gas plant shortly, as Barney Carter and associates have broken ground for their absorption plant foundation, and if oil developments come up to expectations in this new field another plant may be added.

The Phillips Petroleum Company has taken steps to conserve its high pressure gas production in the Ibex field, Shackelford County, since acquiring almost complete control of all oil and gas producing properties in this field. Phillips' combination absorption and charcoal plant at Ibex is dependent upon gas from this field, and since a number of producing wells have been partially shut in to conserve the life of the gas in the field the gasoline output of the plant has taken a sharp drop.

The Chestnut & Smith Corporation of Tulsa is the largest natural gasoline manufacturer in Texas, with a daily average ranging upwards from 150,000 gallons daily, while Phillips Petroleum Company of Bartlesville, Okla., is the second largest natural gasoline producer in the state with a daily average considerably above 100,000 gallons from 15 plants in Stephens, Young, Eastland and Shackelford Counties.

Shipments of natural gasoline from the various manufacturing centers in Texas during the first four months of 1925 follows:

Fields—	Jan.	Feb.	March	April
Eastland Co.	186,325	143,180	165,255	185,110
Stephens Co.	141.645	117,820	131.720	126,670
Burkburnett.	41,770	38,670	37,215	35,480
Shackelford County . .	22,505	21,010	14,460	7 320
Electra . ..	14,215	14 335	14,440	17,165
Young Co. .	11,075	11,215	10,775	4,005
Petrolia-Clay County . .	4,790	4,540	4,670	4,200
Brown Co. .	1,020	....	....	965
Amarillo-Potter Co.	1,060	660	. 905	1,090
Total in Bbls. (42 gals)	.424,405	351,430	379,440	382,005

Crown Central Petroleum Corp. Puts Plant to Work

Houston, Texas.—With the formation of the Crown Central Petroleum Corporation, the refining plant on the Houston Ship Channel has been put on the active list. This plant has been idle for more than a year. It was part of the property of the United Central Oil Corporation, which was taken over in the merger that formed the Crown Central organization.

The plant has capacity of 4000 barrels daily. It is being charged with Mirando crude and zero cold test lubricating oils are being made. The plant was rehabilitated early in the year.

In addition to this plant, the company owns another of 700 barrels daily capacity at Clarendon, Pennsylvania. Both were the property of the White Oil Corporation, whose corporate name was changed to the United Central more than a year ago.

In addition to the United Central properties, the Crown Central Oil Corporation took over the marketing business of the Acewood Petroleum Company, a marketing organization. Further financing was done by New York bankers through an offering of 200,000 shares of no par stock.

A. C. Woodman, formerly head of the Acewood Company, comes to the consolidated concern as chairman of the board. W. A. Williams, president of the United Central, remains president of the new concern. Vice presidents are C. H. Longshore, M. C. Ehlen and Henri I. Grandgerard, the latter of Paris, France. J. K. Garrigues is secretary and treasurer and R. H. Lindsey, assistant secretary and treasurer.

Phillips Buys Plants

Breckenridge, Texas.—Three natural gasoline manufacturing plants operated By Roeser & Pendleton of Breckenridge in Stephens County fields have been purchased by the Phillips Petroleum Company of Bartlesville, Okla., for a consideration of $1,700,000, making a total of 12 operating plants purchased by Phillips within the past two years in Stephens and Eastland counties. Two of the plants sold by Roeser & Pendleton are located in the Curry field, and are making about 25,000 gallons of natural gasoline daily, while the third plant is located in the Eliasville field, with a daily production of about 8000 gallons. The latter plant has been operated under the name of Western Gasoline Producing Company.

The Phillips Petroleum Company recently purchased the Landreth Gasoline Company's huge plant at Ibex and two plants in Southern Stephens County from Wooten & Hughes. Prior to these purchases three plants operated in the Pioneer field by National Gasoline Company, McMan Oil & Gas Company and Helios Gasoline Company were acquired, giving Phillips control of all the gas in the Pioneer field. A plant operated in Stephens County by the National Gasoline Company, and two plants of the National Products Company of California are now owned by Phillips.

AMDYCO Corporation Will Handle AMDYCO Interests

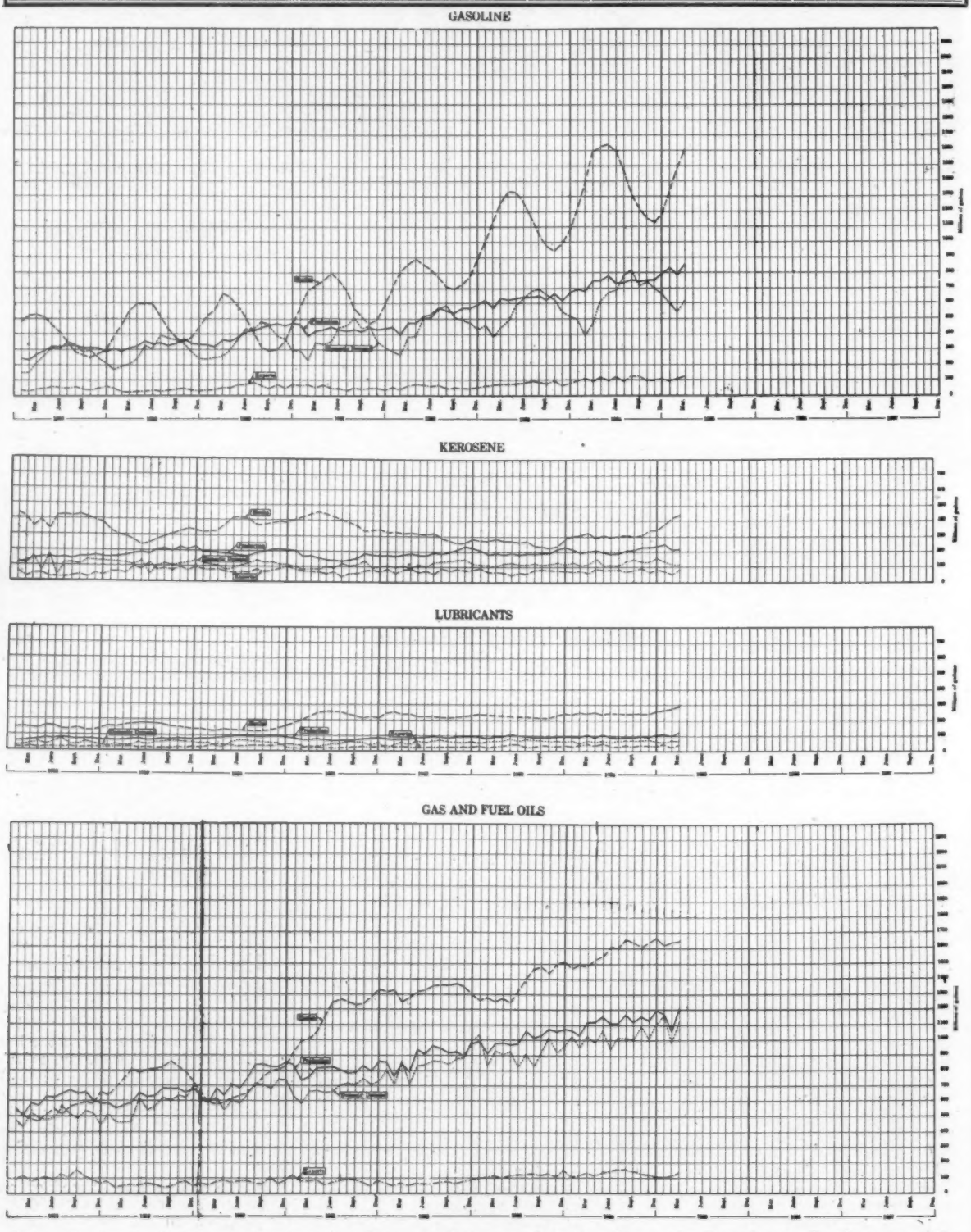
New York.—The American Dyewood Company recently sent out the following announcement to its customers:

"We beg to advise you that our business in AMDYCO has grown to such proportions that we have come to the conclusion that our customers would best be served by operating our AMDYCO interests separately from those of the American Dyewood Company.

"We have, therefore, turned over to a corporation known as AMDYCO Corporation, all our interests in that business, and have assigned to them our rights in various patents, trademarks and everything connected with the AMDYCO branch.

"We thank you for past favors and trust that you will continue to carry Corporation in the same manner as you have with us."

GRAPHS SHOW MOVEMENTS OF REFINED PRODUCTS



Of particular significance to the refiner is the fact that exports of gasoline, gas oil and fuel oil continues to rise slowly. The graphs above covering the period from 1918 through the first quarter of this year show this. They are out of the Department of the Interior.

Since the close of the World War it has been accepted as a fact that demoralized conditions abroad had much to do with the plight of the American refiner. While there has been no sudden jump in exports, the lines do show a steady increase. So, if reduced exports had much to do with low prices, the condition is slowly righting itself.

While the graphs are old, they do show the tendency in the movement of refined products. To that extent they are valuable.

The lines on gasoline show that stocks have been pulling away from production since 1921. Neither has domestic demand increased as has stocks. The rise and fall of stocks comes with the rise and fall of domestic consumption.

Extracts From Refinery Technology

(Continued from page 50)

make them independent of foreign gasoline, and it is interesting to the American refiner to learn of the various substances that are used as starting points in the manufacture of motor fuels. The latest development is the manufacture of a fuel for the internal combustion engine from the pitch that remains after the distillation of coal tar. The fuel is called carbon and it is claimed that the use of it in the ordinary engine produces considerably more power than with gasoline. Further details on this interesting proposition will be found in Autotechnik, 1925, April 19, page 34.

* * *

Sampling Petroleum and Its Products:—The taking of samples of petroleum and its various products for analytical purposes is a matter of prime importance for only when the sample is properly taken is it possible to obtain an accurate picture of the chemical and physical properties of the substance. This matter is discussed in detail in the Polish petroleum journal, Przemysl Chemiczny, volume 9, pages 7-13 and is published in Chemisches Zentrallblatt, 1925, page 2052.

It is stated therein that taking samples of oils, etc., which are contained in tanks of small dimension, tubs or cisterns, small glass tubes are used with a diameter of 15 to 22 millimeters. It is also possible to use various patented devices for taking samples as well as a home-made affair consisting of a large wooden lath to whose lower end there is attached a closed flask. The cork or stopper which closes this flask is attached to a string which, when pulled, causes the mouth of the flask to open and allows the oil to enter. It is well to agitate the contents of the tank while the sample is being taken, and this can be conveniently accomplished by means of a wooden board which is perforated with numerous holes and is drawn slowly through the oil in a vertical direction.

In the case of tank cars, transporting petroleum distillates, the sample is generaly taken through the outlet pipe. This is done for the reason that the impurities in the distillate will be found in the lower part of the car and if the sample were taken at the upper part, these impurities would not be detected.

When a sample of oil is taken from a large container an apparatus is used which is made in the following manner. An iron cylindrical tube of about one liter capacity is provided with a cone-shaped piece of plug at its lower end. This piece hangs loosely in the tube. Both the cylindrical tube and this plug are attached to thin wires, and by pulling on the wires the tube may be closed at any time. The two wires are wound separately on two rollers. The apparatus is transportable.

* * *

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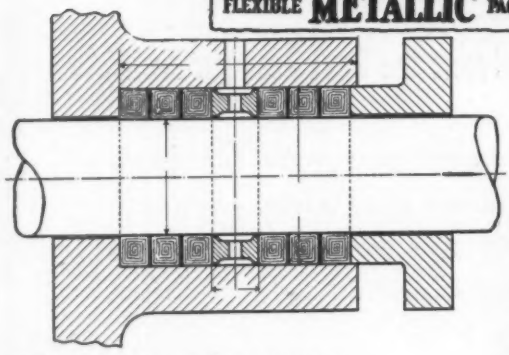

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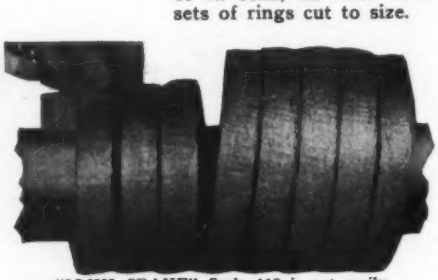

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On a system discharging gases to a line, under light vacuum, it is sometimes desirable to maintain atmospheric pressure.

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a bug-a-bear in the average refinery and the methods and processes for both avoiding emulsions as well as for destroying them after they form are many. An interesting apparatus which can be used for this purpose is described in the German magazine, Petroleum, volume 20, 1887-91.

The apparatus in question works on the well-known principle of emulsion separation which consists in the reduction of the surface tension by means of an increase in the temperature. In order to avoid losses of volatile petroleum products during the evaporation, as well as the boiling of the separated water at temperatures in excess of 100 degrees C, which results in a circulating effect on the water which renders the separation still more difficult, the process is carried out in apparatus which are hermetically sealed. Thus when the working temperature reaches between 120 to 140 degrees C, the pressure in the apparatus is from two to six atmospheres.

The process is a continuous one and the apparatus consists of two vertical boilers which are provided with accurately regulated reducing vales. One of these boilers acts as the preheater for the emulsions, while the second of the two performs the actual operation of separating the water and oil. This is accomplished within a period of from two to four hours. The heating is accomplished with the aid of steam which is made to flow through a closed coil in the preheater. The dehydrated oil is also made to give up its heat to the steam by means of a properly constructed heat exchanger. An apparatus of the kind described is in actual operation and dehydrates about 35,000 liters of crude oil a day. In the original article there will be found a picture of the apparatus and detailed data on its operation.

* * *

Fractional Distillation of Petroleum: —The apparatus shown is for the fractional distillation of oils. The oil is vaporized and passed through a dephlegmator through which circulates a stream of cold liquid identical with the desired condensate. Vapors passing through a pipe 30 to the first of a series of dephlegmators 11, and then through pipe 31, 32 to successive dephlegmators, and finally through a pipe 33 to a condenser 100. The condensed vapors are drawn off through pipes 35, 36 and 37, which by suitable valves can be connected to pipes 38, 39 and 40. Each of the latter delivers the condensate to a cooler 42. British Patent No. 231,334.

* * *

Determination of Lead Tetra-Ethyl in Gasoline: — Chlorine is bubbled through 100 cubic centimeters of gasoline until the liquid is saturated, and the liquid, together with the precipitates is shaken two or three times with dilute hydrochloride acid. The acid extracts, which contain the lead compound in solution, are separated from the gasoline and boiled together for

one-half hour preferably under a reflux condenser, and the lead is precipitated as lead chromate by the successive addition of sodium acetate in excess, and potassium chromate. The liquid is kept hot until the lead chromate coagulates, when it is filtered through a Gooch crucible, and the precipitate is dried and weighed. The method gives consistent results with synthetic mixtures, but the results are about 7 per cent and 4 per cent too low with lead tetra ethyl and lead tetramethyl, respectively. Journal of the Institute of Petroleum Technology, volume 10, page 954.

Hypochlorite Process: — The hypochlorite process which is used for the purpose of removing the sulphur that is present in petroleum distillates possesses the following advantages in comparison with the sulphuric acid process.

1. The cost of refining is reduced and this particularly so when lime is used in the place of sodium hydroxide (caustic soda) and hypochlorite of calcium in the place of hypochlorite of sodium.

2. The loss of oil in the refining process is less.

3. Acid muds are not formed and therefore there is no need for installations for recovering the sludge acids.

4. The process may be carried out in ordinary steel apparatus, as there is no corrosion of the piping, etc., by acid. Lead lined apparatus need not be used.

5. The entire operation of the process is less complicated than the acid process.

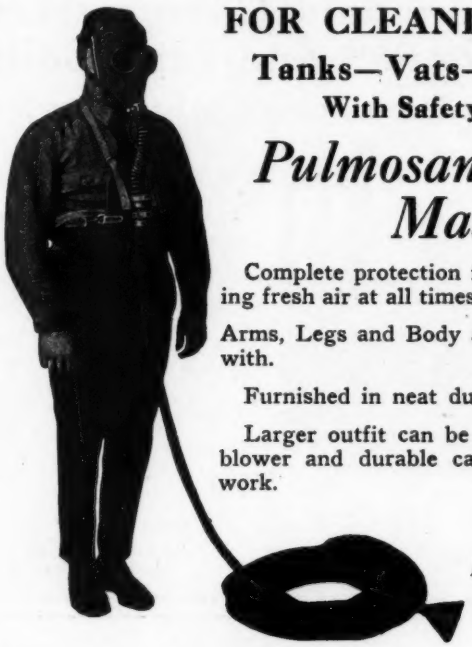
6. Aromatic hydrocarbons of value are not lost by transformation into sulphonic acids as in the case of the acid process. The danger of the formation of alkyl sulphates soluble in the petroleum is avoided. These compounds afterwards decompose to form sulphuric acid which attacks the tanks in which the oils are stored.

The original article from which this information is taken was published in the Dutch chemical journal, Chem. Weekblad, volume 21, pages 193-199.

Cracking Without Vaporization:—Oil is cracked under pressure without first being vaporized. Then the cracked oil is distilled in a distillation apparatus and the distillate is again subjected to cracking. The process is carried out in a continuous manner. The residues remaining after cracking are removed and the distillate is returned to the fresh oil pipe line without interruption. For further details see German Patent No. 370,470.

* * *

Purification of Mineral Oils:—Mineral oils, which contained non-saturated compounds, are purified by being allowed to come in contact with chlorine water or an aqueous solution of hypochlorous acid. The product is then treated with an alkali which con-



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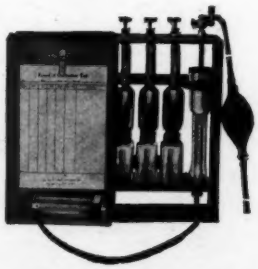

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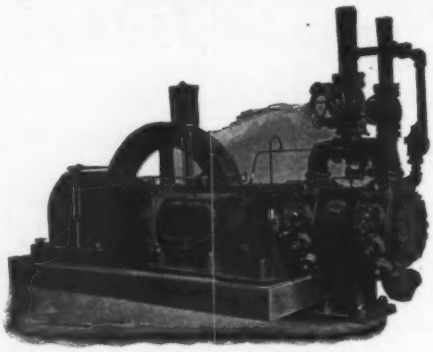

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verts the chlorated products thus obtained into ethers and salts. Gasoline obtained from the cracking of heavy oils should be subjected to preliminary treatment, such as filtration through bauxite, the action of a mineral acid, chloride of aluminum or zinc salts, in order to polymerize the most active of the non-saturated compounds. British Patent No. 204,078.

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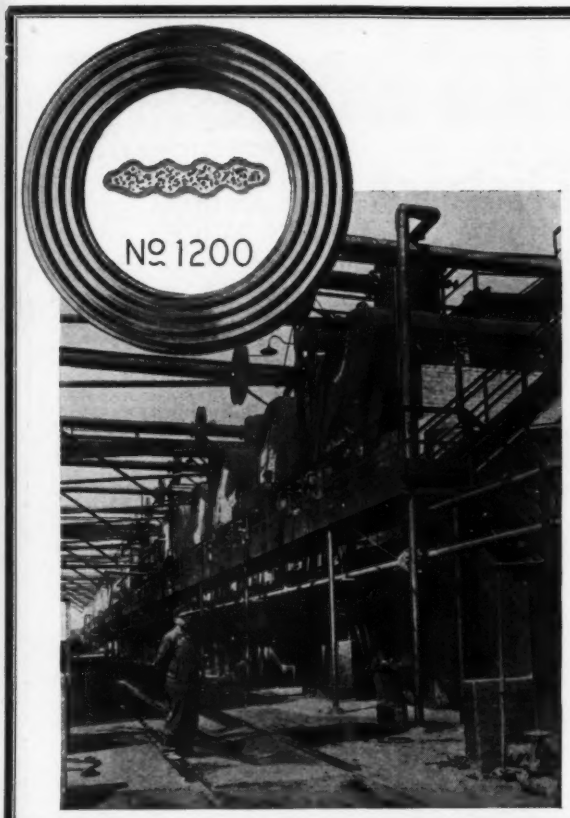

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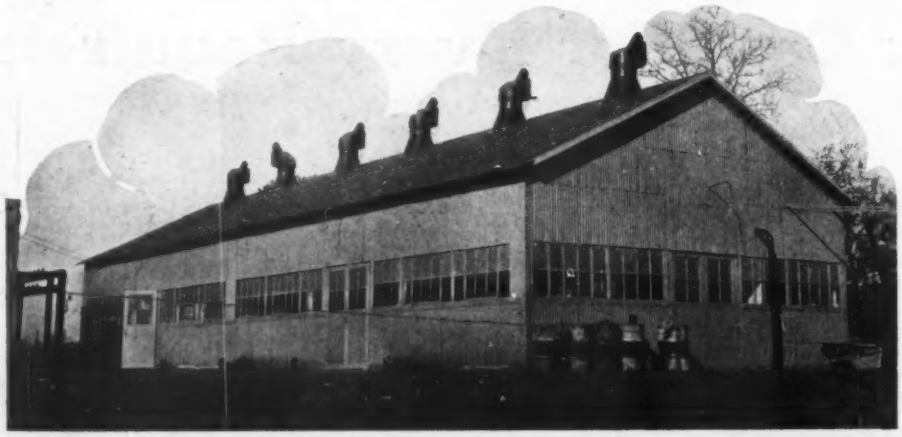

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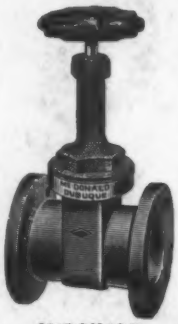

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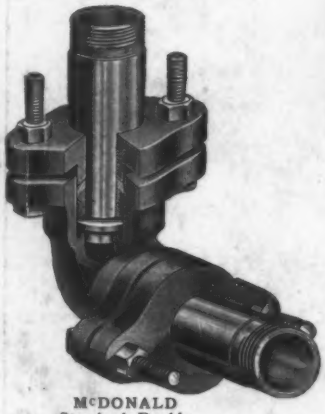

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